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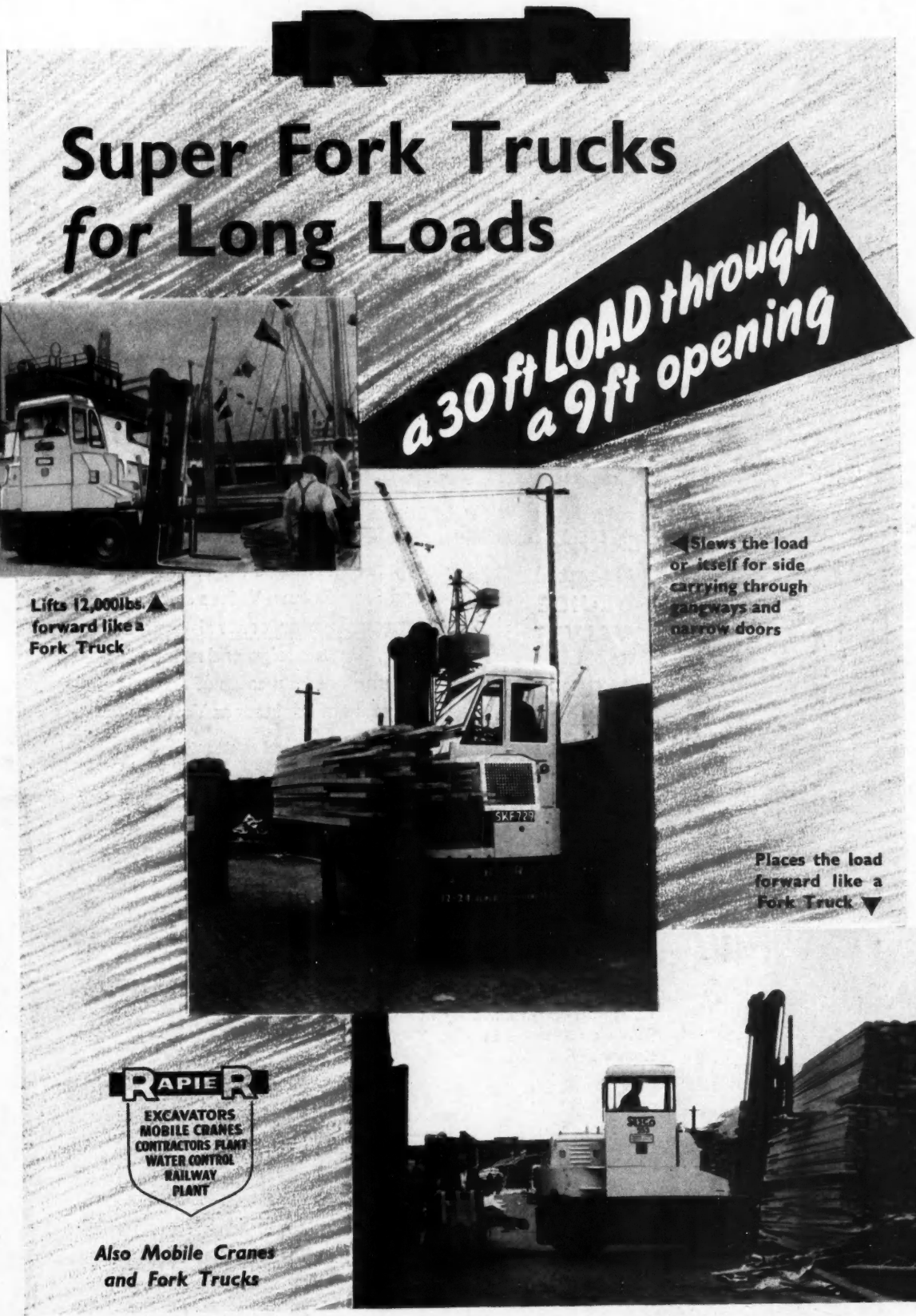
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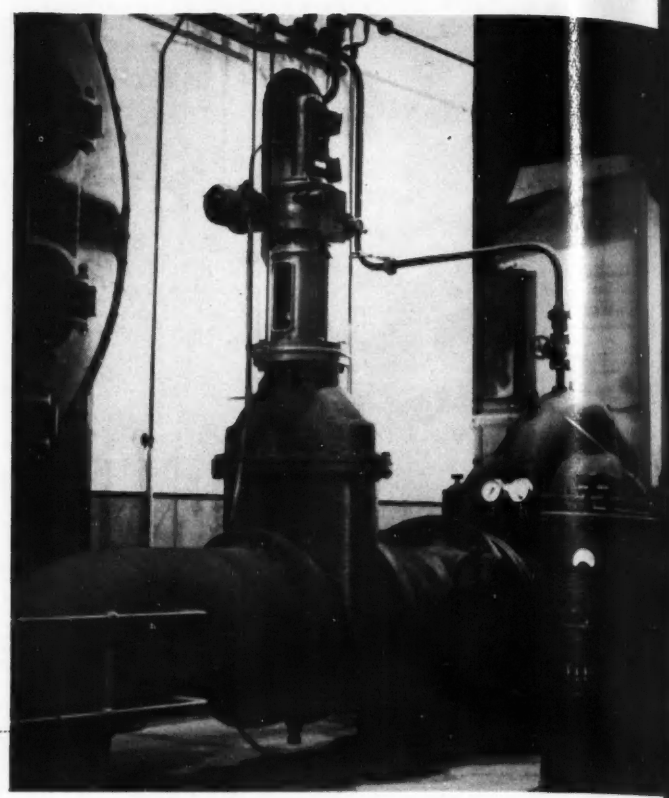

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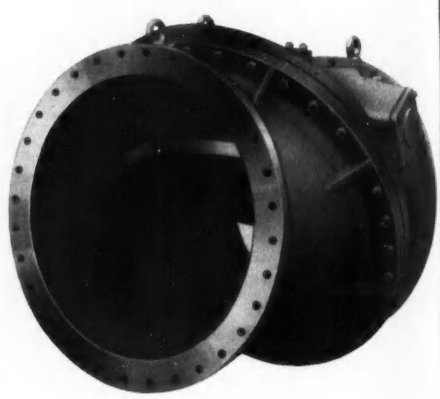

The site photograph shows a 24 in dia. inside non-rising screw electrically operated Sluice Valve and a similar sized Tilting Disc type Reflux Valve. The other illustrations show a 36 in dia. outside rising screw electrically driven Sluice Valve and a 48 in dia. Tilting Disc Reflux Valve.

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THE ENGINEER

VOL. 201 No. 5232 MAY 4, 1956

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AS OTHERS SEE US

It is invariably interesting to hear what others think of us. "O wad some Pow'r the giftie gie us, To see oursels as others see us!" Proverbially the result is humiliating. "It wad frae mony a blunder free us, And foolish notion." Those words, it is to be noted, came from a poem entitled "To a Louse." But when Sir Maurice Bowra looked last Friday, as a layman, at the work of engineers in the lecture which we print on page 432 of this issue, the result was far from humiliating. Only towards the end did he make his audience feel at all humble, and then only because he saw the great powers for good and evil that lay in their hands.

In the nature of things of course—for no one accepts completely another's criticism—there were remarks that Sir Maurice made which we feel disinclined to agree with. For example, is it really true that "the Romans, like the Chinese, rejected machines, in the last resort, because their ruling classes were snobs?" Sir Maurice surely came closer to the mark when he pointed out that "the trouble with the ancient world was that it never had any difficulty in finding men to do tasks which we assume should be done by machines." For exactly the same reason some of the great engineering works carried out in India and S.E. Asia earlier in the present century were constructed not by machines but by muscle power. It is, too, significant that steam power, the advent of which signalised the beginning of our dependence upon power from heat rather than muscle power, wind power or water power, only found favourable soil for its early development where neither muscles, wind power nor water power could any longer suffice—the drainage of deep mines. Nearly a century had to pass before steam power became cheap enough to compete effectively in other fields. But once it did compete it so contributed to raising living standards, and thus to the raising of wage rates, that its economy could soon no longer be called in question. It started that beneficial process whereby steadily increasing real wage rates have made more and more mechanisation profitable, thereby heightening productivity and living standards and pushing real wages further up the scale. Snobbery it may have been amongst the Roman intellectuals to scorn the devising of anything practically useful. But the more practical men—Rome was rich in such men—who might have made the advance, just as eventually it was practically minded men like Savery and Newcomen who started the Industrial Revolution, found the way barred by economics. Engineering in its roots owed rather little to science; and to this day it draws less upon pure science than pure scientists would like to think. The practical man of the past has had to turn theorist to-day and develop for himself the science of engineering. In fact, engineering is not, as is sometimes assumed, and as, perhaps, Sir Maurice assumed, an offshoot from the tree of science, but a separate growth.

It was when he came to consider our own times that Sir Maurice trod upon surer grounds; and, on the whole, as a layman looking at engineering, he proved to be not only mild in criticism but downright encouraging in praise. For unlike many other intellectuals, he did not look back nostalgically to some Golden Age in the past which was unsullied by too much machinery. He proved robustly confident that ours is a good age in which to live. "Life is more agreeable now for the mass of mankind than it has ever been ..... due to man's increasing conquest of nature through machines." Nor was he unduly depressed because through the work of engineers man's powers of destruction have been so vastly increased. For "if we regard politics as the struggle for power, engineering is not a political activity. It aims at something quite different—the control and exploitation of natural resources to give a greater degree of human welfare."

Political factors may indeed lead internationally to the outbreak of wars. But within any nation engineering acts as a stabilising influence. For it tends "to suggest that there is a cure for most evils and that the age-old troubles of man, such as starvation, disease and floods, and the like, can be surmounted by a proper use of machines." Men turn desperately to violence as a cure only when promises of improvement are not fulfilled. Engineering not only holds out great future promises; but has behind it a great record of fulfilment. Indeed, though statesmen have often taken the credit, it is engineers through their beneficial works who raise standards of feeding and of comfort and of security that have pacified so many provinces of the world that used to be wild and turbulent. Nor was Sir Maurice unduly perturbed by the trend towards mass-production, which may substitute "the dead products of machines for the fine work of men's hands" and may destroy "the grace of life even in the small select circles where it is still cultivated." He stoutly rebutted the idea that a civilisation becomes degraded as soon as the cultivated tastes of a few are shared by many. "There is no real reason why a world which relies on machines more than on handicrafts should not in the end produce objects as satisfying as those of old craftsmen." But why, we wonder, did he qualify that statement with those words "in the end"? For, as our contemporary, *Nature*, recently remarked: "To enthuse over Gothic churches and Tudor town halls and not even to glance at "Viscount" aeroplanes and stressed concrete bridges cannot be justified on the grounds that only the former are creative arts of man." Sadly we must agree with Sir Maurice that many present-day products of machines are abominably lacking in taste. But not all! Improvement does not all lie in the future, as he implies. A few even of the domestic, machine made products of which he may have been thinking, can bear comparison æsthetically with the best from the past.

FIGHTING SERVICES

The Estimates for the Fighting Services, presented during the period when the printing dispute made it impossible for us to discuss them, indicate no striking developments during the past twelve months. The Government's aim at the present time is to have smaller and better equipped forces and to make every possible economy in "the tail," in preparation for the heavy defence commitments facing us in the near future. A stockpile of thermo-nuclear bombs and V-bombers to deliver them have to be built up as a deterrent, together with "its essential complement"—an effective home defence system of fighters and guided missiles; new ships of cruiser type and destroyer escorts, equipped with anti-aircraft guided missiles, are to be laid down; the Armed Forces are to be re-equipped with nuclear weapons; carriers are to be adapted to operate modern aircraft; and warships—in the first instance submarines—are to be built with atomic power plants. These are large commitments in relation to a defence budget which is already at a maximum, unless taxation is to be increased or expenditure on social services reduced. Meanwhile the Government's defence policy is clearly on the right lines, with the possible exception of over expenditure on V-bombers, having regard to the massive deterrent provided by the United States Strategic Air Force. Global war is considered to be much less likely than an intensification of the cold war and all personnel and ships not required for the cold war will be dispensed with if they cannot be made available for service at short notice. The Air Force underspent its budget for last year. But the Navy—at £346 million—gets £5,500,000 more and the Army—at £472 million—gets £2,000,000 less than in 1955-56.

In his explanatory Statement, the First Lord made crystal clear the main purpose of the Navy in global war—to retain control of the seas by destroying enemy surface ships, submarines and aircraft. This should do much to clarify the statement in the Defence White Paper of a year ago: "the Navy's heavy carriers will contribute to the Allied striking fleet's ability . . . to hit the enemy independently." Unlike the United States carriers, British carriers are not, and are never likely to be of a size which enables them to launch "Canberra" bombers at targets 1000 miles inland. It is interesting in this connection to note that the first of our five slow (24½ knot) carriers is now to be fitted with the angled deck and that "in subsequent years other carriers (the remaining four) will be brought up to date in their turn." With catapult launching, and landing-on speeds reduced by devices now under investigation, these vessels should be quite capable of operating the types of naval aircraft we require. It is clear, however, from the decision to modernise our slow carriers, that the concept of the "battle-group centred round the modern carrier" must in the foreseeable future be based on our seven fast and five slow carriers, all laid down during the war and far too few "to retain control of the seas." The new naval day fighter, the N.113, is as yet only in the prototype stage and the all-weather fighter, the DH110, has only now completed carrier trials. Two more fleet escorts, of destroyer type, are to be added to the two authorised in last year's programme and all four are to be equipped with A.A. guided missiles. Ten more frigates are to be ordered, seven being of specialised types. It is the Admiralty's intention to employ nuclear power for propulsion, in the first instance in submarines. But reactors are still very costly and in the light of other and more urgent commitments we are unlikely to have even submarines with atomic power plants for several years yet. The Secretary for War again gives a most interesting description of the Army's operations in various theatres. He refers also to the formation of the 24th Independent Infantry Brigade, to be earmarked and trained for service anywhere, and kept available for immediate dispatch in Prestwick-Pioneer aircraft. Trials of a new armoured car, the Saladin, and of new signal equipment are in hand and production plans have been made for the F.N. rifle, which has passed its trials. Issues of the heavy gun tank "Conqueror" to the Rhine Army should be completed by the end of 1958, and supplies of the American surface-to-surface bombardment missile "Corporal" are due this year. The need for equipment to be air-portable and to be capable of movement across country and rivers is receiving special attention. Armour is to be integrated in the infantry brigade and medium artillery added to the division to provide strong hard-hitting groups of all arms. Coastal Artillery is to be abolished.

The Air Estimates—at £479½ million excluding United States aid—are £34½ million less than for last year, largely due to underspending on aircraft production. Orders for a number of "Hunters," and "Seamew" and long range "Shackleton" anti-submarine aircraft, have been cancelled because of the need for other kinds of aircraft. There have also been production delays on the all-weather "Javelin" fighter. Though orders for a number of "Valiants"—the only V-bomber now in squadron service—have been cancelled in the light of the more powerful "Victor" and "Vulcan" bombers now in production, it would seem that our defence plans attach undue weight to the counter offensive. No doubt "offence is the best form of defence."; but something more than lip service should be paid to its essential component—fighter and guided missile defences. Nearly three years have passed since the A.O.C. Fighter Command assured us that a co-ordinated plan was being worked out for home defence, but there is still no evidence of it. Were it not for the generosity of the United States in providing us with "Hunters," the fighter position would indeed be precarious. The guided weapons situation is even worse. The first air-to-air guided missiles are to be issued during this year, but ground-to-air missiles with a range of 40 or 50 miles, to destroy bombers well out at sea, are not yet beyond the trials stage.

A Seven Day Journal

South Wales Steel Plant Extension

THIS week, the Steel Company of Wales, Ltd., has announced its third development plan, which has received the approval of the Iron and Steel Holding and Realisation Agency. The plan is designed to increase steel ingot production at the Abbey Works, Port Talbot, to 3,000,000 tons a year by 1960, and the necessary work is to be started immediately. The scheme, which has been prepared at the request of the Iron and Steel Board, makes provision for converting the ingots into steel sheets and plates, as well as tinplate, to assist in meeting the anticipated increase in demand for flat rolled steel products in 1960. The company says that its production capacity for sheet and tinplate will be increased by about 435,000 tons a year. The work involved includes the building of a new coal washery capable of handling 250 tons an hour, an additional battery of eighty coke ovens on a site at the south-west end of Abbey Works, and a fifth blast-furnace which will have a hearth diameter of 30ft 3in. There is also to be a new steel shop for producing by the Bessemer process all the additional steel, and the slabbing mill at the Abbey Works is to be converted into a universal mill by the addition of vertical rolls. The mill will then be capable of rolling 60,000 tons of ingots a week. The existing 80in continuous hot strip mill, it is stated, is able without alteration to roll the 50,000 tons a week of hot strip which will be required. Other items in this third development plan are the installation, at the Abbey Works, of a new 56in four-stand cold reduction mill to process thin sheets, and the installation of an additional electrolytic tinning line at the Velindre tinplate works which are now approaching completion. The Steel Company of Wales, Ltd., estimates that the plan will involve expenditure at the rate of £12,000,000 a year for four years, a large portion of which, it says, will be found from internal sources.

Institution of British Agricultural Engineers

THE eleventh annual general meeting of the Institution of British Agricultural Engineers was held in London last Monday. The report of the council, which was approved by the meeting, shows that last year the membership of the Institution increased to 1491, and that there are now six local centres in various parts of the country. In the section of the report which surveys the Institution's educational activities, it is noted that thirty-two candidates sat last year for the National Diploma in Agricultural Engineering examination and that sixteen of them gained the diploma. The report passes on the comments made by the examiners about the "indifferent standard of English" revealed in the examination papers, and the importance of this matter is emphasised particularly for those who intend to undertake a professional career. The report refers also to the proposals for a British College of Agricultural Engineering which the Institution has submitted to the Ministry of Education and to the Ministry of Agriculture. Mr. D. R. Bomford has been re-elected president of the Institution, and Mr. Eric Alley has been elected a vice-president. A well-attended luncheon followed the annual meeting, the principal guest being the Minister of Education, Sir David Eccles. In a speech proposing the toast of "The Institution of British Agricultural Engineers," Sir David said that most careful consideration was being given to the suggestions put forward for a college of agricultural engineering. The one argument in the proposals, he said, which strongly appealed to him was that such a college was needed if we were to attract students from the Commonwealth and other overseas countries. After a response had been made by the president, the toast of "The Guests" was proposed by Mr. Ben Burgess and acknowledged by Sir James Turner.

100 Years Ago

The Engineer

(MAY 2, 1856)

"SUPPLY OF SALT WATER TO LONDON"

"A scheme has been announced by Mr. Francis Fuller for supplying sea-water for cleansing and watering the streets, courts, alleys, and other places in the metropolis. Referring to the provisions of the Metropolitan Local Management Act, and the compulsion thereby imposed on the owners of house property to furnish a supply of water sufficient for general cleansing purposes, the promoters of this scheme profess to study economy by constructing 'a canal on the north side of the Thames by which pure sea water shall, at each tide, be received into reservoirs at a sufficient elevation above London to supply every house in the metropolis, and in such quantity that every street, court, and alley could be washed each day with it.' The supply of public fountains, baths, wash-houses, and Zoological Gardens, and of lakes in the parks, is also proposed as among the purposes of the plan, 'and by pipes under the Thames, the south side of London might be supplied as well as the north.'

"The importance of the object sought—viz., an unlimited supply of water for general cleansing purposes, and at a less cost than that necessarily incurred by the filtering and other processes to which fresh water is subjected, is undeniable. How far the projectors have succeeded in discovering the best and most economical method for ensuring this supply, we are not, wanting further details, in a position to discuss; the proper persons to whose charge it should be committed, and the proper machinery for working the scheme, are subjects for consideration, on which strong opinions are likely to be expressed. . . . London should drain itself, clean itself, and improve itself, pay for the work it wants, and enjoy the profits and advantages secured by the money of its population. . . . Without pledging ourselves at present to the belief that *salt* water is a *desideratum* in London streets, we commend Mr. Fuller's proposal to the best attention of the Metropolitan Board of Works."

Opening of Oxton By-Pass

THE Minister of Transport and Civil Aviation, Mr. Watkinson, inaugurated the Oxton by-pass road, part of an improved route from Leicester to Newark, on Tuesday, April 24th. Although this road is only a small-scale job, it is of interest because it has been used as a sort of full-scale proving ground for modern plant and design methods, in anticipation of road construction on a large scale later on. The technical significance of the work was outlined in a recent paper read before the Institution of Civil Engineers —"The Oxton By-Pass Extension," by Mr. R. A. Kidd—and a note about the points of special interest in the paper appeared in our issue of February 10th last. The section of the by-pass on which work started in 1946 incorporated concrete slabs of various thicknesses, reinforced and unreinforced, and observations of their behaviour formed a guide for the Road Research Laboratory in evolving a method of design for concrete roads. The second part of the work, now finished, was utilised to find practical standards of surface irregularity (and hence of riding quality) and to try out plant adapted from airfield construction. The County Surveyor of Nottingham prepared the scheme, John Laing and Son, Ltd., was the contractor, and the Ministry and the Road Research Laboratory helped with the experimental work. This second carriageway was built in a single stage to its full width of 24ft. The contractor has made a film entitled "Concrete for Roads," which shows the work in progress, and brings out the problems of organising such a highly mechanised constructional job into a sequence of operations —batching of concrete materials at a central station; transport by lorry to a paver-mixer travelling beside the carriageway; spreading and finishing machines and a wet-surface profilometer, spanning the full 24ft, on rail tracks; and finally machines for cutting and sealing the joints.

Institute of Fuel Annual Luncheon

MR. R. H. GUMMER, the president, was in the chair at the annual luncheon of the Institute of Fuel, which was attended by about 600 members and guests and was held on Wednesday, April 25th, at the Connaught Rooms, Great Queen Street, London. After the loyal toast the president presented the Melchett Medal to Sir Alfred Egerton and announced that the Melchett lecture would be given in the autumn, and he then went on to propose the toast of "The Guests." Mr. R. P. Morison, Q.C., independent chairman, British Iron and Steel Federation, responded and had something to say about the problems of the steel industry which, he stated, was the largest industrial user of power. Consumption by the industry, he continued, amounted to about 30,000,000 tons of coal equivalent of solid and liquid fuel, or one-eighth of the nation's fuel supplies, and represented some £150 million, or 20 per cent of the operating cost of the industry. The maximum economy in the use of fuel was essential and, to effect this, elaborate techniques were being devised for the crushing, grading and screening of ores with a view to reducing the amount of coke used per ton of iron produced. With partial preparation of the ores, Mr. Morison said, coke consumption had fallen from 27 cwt to 22 cwt per ton and dropped to 18 cwt with fully prepared burden. Other economies were being attained in the use of coal in carbonisation and the 1950 consumption of 7,500,000 tons of non-coking coal was reduced to 6,000,000 tons by last year. This trend, he continued, was expected to result in a further reduction of 13 per cent in the next three years, associated with an increase of 15 per cent more steel. Higher efficiency in the use of fuel, Mr. Morison added, was being achieved by automatic control and instrumentation of the furnaces and the reduction in heat losses by better integration in the stages of manufacture. Another factor having a large influence on future fuel requirements was the continuous rise in the production of steel, which, he thought, might reach a total of 28,000,000 tons by 1962 and require about 30,000,000 tons of coking coal.

Impact of Engineering on Society

By Sir MAURICE BOWRA, F.B.A., M.A.*

No. I

The Second Graham Clark Lecture was presented last Friday, April 27th, before a joint meeting of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Electrical Engineers. It is here reprinted nearly in full. The author is not an engineer. But he suggests "it is often profitable to see ourselves as others see us, especially if we practise some highly skilled and specialised pursuit." He turns out to be a kindly and entertaining critic.

MAN, says Beaumarchais, differs from the beasts only in drinking without being thirsty and in making love all the year round. However important these differences may be and please do not think that I underestimate them, I would claim that man differs from the beasts mainly in being able to turn nature to his own use. Of course, some animals can do, this, but only on a very small scale. The pride of man is that he has already done so on a large scale, and seems likely to do so on a still larger one. By the construction of inanimate objects, which we call machines, we have extended on an incalculable scale what we are able to do. The process began a very long time ago, but is has on the whole been slow until quite recently, and it has by no means been regular. At the very start are the unknown inventors, who made discoveries which indeed showed what the control of natural forces may mean. If, as is posssbile, Pekin man, *Pithecanthropus Pekinensis*, really knew how to make fire, it is possible that he should be regarded as our forerunner, since without his discovery nothing would have happened. If he was closer in his structure to the apes than to *homo sapiens*, our debt to the beasts is greater than we usually admit and there is much to be said after all for having our ancestors not in Paradise but in the Zoological Gardens. If Pekin man does not quite qualify to be the patron saint of engineers, he should perhaps be remembered on their Founder's Day and have a place in their Golden Book of Benefactors.

Now almost every society of which we know anything practises engineering to some degree. Even the Australian aborigines invented the boomerang, which was an ingenious and amusing means of hitting your enemies. But it is only in the last hundred or so years that society has really become mechanised on a large scale. The difference between ourselves and the ancient Egyptians is not that we admit the existence of engineering and they did not, for after all the construction of the Pyramids was an extraordinary achievement, but that they did not see the range of its possibilities. A considerable degree of civilisation can be secured with a minimum of engineering, and though we must certainly admit that without engineering civilisation is not impossible, it is always of first importance. In the eighteenth century China under the great Manchu Emperors not only appealed to the philosophers of the west as a model of good government and social graces, but can be seen to-day to have shown a remarkable capacity for organising an enormous area into law and order and for producing, at least in a limited class, a high degree of intelligence, sensibility and creative endeavour. The Chinese, who led the world in the invention of printing, the mariner's compass, and gunpowder, did not advance from these auspicious beginnings but evolved a civilisation in which engineering had almost no place. Even their buildings graceful and charming though they are, were modelled on tents and called for no great skill in their erection. It is true that the Emperors used Jesuit missionaries to make fountains and clocks, but there they stopped. So far as the external equipment of life went, China in the eighteenth century differed in no essential respect from China in the first. The Chinese, for all their intellectual gifts, failed to see how important even clocks and fountains might be to those who understood the principles on which they worked, and in due course they paid heavily for this when a mechanised Europe attacked them and imposed its will on them.

* Warden of Wadham College, Oxford.

Greco-Roman Neglect of Applied Mechanics

An even more notable example of this neglect can be seen in the Greco-Roman world. The Greeks were in some respects pioneers of engineering, and the many buildings which still bear witness to Roman competence belong to the same tradition. There were indeed times when it looked as if the Greeks were on the verge of great mechanical discoveries. Archimedes was not only a mathematician of incomparable genius but at times turned it to practical uses, as when he invented hydrostatics or devised engines of war to confound the Roman besiegers of Syracuse. Yet, despite these promising beginnings, the Greeks stopped and did no more for engineering. Nor did the Romans after them. And for this, like the Chinese, they paid a heavy price. If the Romans of the later empire had only had another Archimedes to invent new engines of war, they would have had no more difficulty in disposing of Attila and Alaric than Kitchener had in disposing of the Khalifa. The trouble with a society which does not believe in engineering or see its possibilities is not that it cannot be civilised, but that it is not likely to survive. Civilisation is a sensitive plant, and its first duty is to look after itself.

This failure of two great systems deserves a moment's notice. We cannot but ask why neither China nor the classical world exploited the possibilities of engineering. Whatever the cause was, it cannot be ascribed to religion. Neither the system of Confucius nor the Olympian Pantheon was opposed to the mechanical sciences. Indeed in their early days the Greek gods were regarded as patrons at least of building and handicrafts, and Hephaestus was without doubt an engineer in the modern sense when he made mechanical beings to work for him in his arms factory. The explanation must lie elsewhere, and perhaps we may find an illuminating hint in what Plutarch says of Archimedes and his more practical inventions :

"Though these inventions had obtained for him the renown of more than human sagacity, he yet would not deign to leave behind him any written work on such subjects, but regarding as ignoble and sordid the business of mechanics, and every sort of art which is directed to use and profit, he placed his whole ambition in those speculations the beauty and subtlety of which is untainted by any admixture of the common needs of life."

Now we might think this no more than the personal whim of a pure mathematician who preferred his own chosen field of geometry to any impure application of it. But the important fact is that this was the normal attitude both in the Greco-Roman world and in China. The engineer was somehow thought to be sordid and engaged in tasks below the dignity of a civilised man. We might, of course, say that you must expect this to happen when education is almost entirely based on the study of literature and words have such a priority of prestige that anything else fades before them. Now this may well be true of China or imperial Rome, and I must admit with regret and shame that too exclusive a study of words may well breed illusions of grandeur about their pre-eminence and blind their devotees to other matters of first importance. But this is hardly true of Archimedes. He was certainly not a pure product of a literary education. He had behind him some three hundred years of mathematical and even of scientific thinking, which did not shrink from experiment and liked to confirm its theories by precise observation. It looks as if we must look deeper for an explanation.

The contempt for applied mechanics displayed by Archimedes was a product of a society in which there was no shortage of cheap human labour. The trouble with the ancient world was that it never had any difficulty in finding men to do tasks which we assume should be done by machines. Some of these tasks must have involved a hideous expense of effort, and whether we think of the Pyramids or Stonehenge or the Great Wall of China or the roads of the Roman Empire, in each case we must remember that, though some mechanical appliances were used, most of the work was done by human hands. The existence of an inexhaustible labour-pool, of men who for the barest and meanest subsistence were able and ready to carry out tasks of great physical difficulty, meant that the educated and governing classes never turned their minds to other, and better, ways of getting such work done. Their minds, so brilliant and active in other ways, were on this point closed. Because human labour was so abundant, it never occurred to them that this was not the best way of doing what they wanted to do, still less that it could not do everything possible for men. They assumed that this was the unchanging pattern of human life and never looked beyond it. If inventions were to come, they would not be from those who alone had the power to see that they were used, and if some more far-sighted man saw their possibilities, the chances were that he would find nobody to listen to him. By a happy accident we have a treatise written by such a man at the end of the fourth century A.D. We do not know his name, but his tract *On Things of War*, which recommends some ingenious new military engines, shows the position, when he says :

"It is universally agreed that in the technical arts (among which we include the invention of weapons) progress is due not to those of highest birth or immense wealth or public office or eloquence derived from literary studies, but solely to men of intellectual power (which is the mother of every excellence) depending as it does on a happy accident of nature."

The Romans, like the Chinese, rejected machines in the last resort because their ruling classes were snobs.

This is a social fact of first importance, and it is not irrelevant to modern times. The prodigious growth of engineering since the end of the eighteenth century has indeed been rendered possible by the epoch-making

inventions like the internal-combustion engine, but this itself would never have happened, or at least never have been turned to general use, if there had not been a complete change towards the part played by engineers in society. The old snobbish position had been so complacent that it was not so much hostile to engineering as completely oblivious of it. What was needed was something to break this complacency and suggest that after all engineering might do good even to those who thought they needed it least. This change was mainly due to the vast revolution worked by the dramatic appearance and rapid growth of natural philosophy. Just as the first Greek scientists moved without difficulty from inquiring about the nature of Being into inquiring about the nature of Becoming, and thereby opened the door to all kinds of physical speculation, so the natural philosophers of the seventeenth century saw that it was impossible to separate the nature of things from their appearances, and conducted experiments to see how things work as they do. The revival of observation and experiment, which had been almost dead since Aristotle conducted his great researches into biology, meant that nature began to become intelligible, and when this happened, men saw that they could make use of it.

This momentous change was not made without obstacles. Even after the foundation of The Royal Society and the first brilliant outburst of scientific speculation which came with it, it looked at one time as if it would again fade away as it had centuries before. It was saved by the recognition that machines could do much that men cannot do by themselves, and though such an idea might still seem absurd or repugnant to the select and privileged few, it was welcomed by others who saw in it a hope for improving their own lives and conditions. Economic forces undoubtedly played an important part. Once they began to undermine the old social order and to create opportunities for many who had hitherto been forced to be content with a humble station, they set new challenges which soon found responses. Once it was clear that it was both profitable and honourable to know about mechanics, mechanics began again to produce its own men of genius, and from the time of Newton onwards the process has continued not merely without interruption but with ever-increasing force and popularity and respect.

It is important to note that this vast change has not been revolutionary in the political sense. It has indeed changed the whole appearance of society and done much to change its structure, but it has not been aided by political revolution or had very much to do with it. The leaders of the French Revolution were not the new and small class of engineers but lawyers, doctors, lapsed priests and impoverished journalists. The Russian Revolution made its first and by far its strongest appeal to a peasantry appalled by the destruction of war and hungry for land. The Chinese Revolution was the final stage of a long struggle against officials, land owners and money-lenders. In none of these did applied science play any leading part or supply anything like a revolutionary ideology. Indeed, we may suspect that if these three countries had been more mechanised than they were, revolution might not have come at all or have come in a different, less virulent, form. It was because these people felt that violence was the only solution for their troubles that they took to it. Now engineering tends to suggest always that there is a cure for most evils, and that the age-old troubles of man such as starvation, disease, floods, and the like, can be surmounted by a proper use of machines. It is indeed significant that the classic case of growth without revolution should be in a country which has used engineering on the greatest possible scale. The United States, which was brought to birth by revolt, has, despite the inevitable disorders of its first expansion and the catastrophe of the Civil War, never come near to social revolution and seems determined at all costs to avoid it. This is all the more remarkable when we consider how many immigrants in the nineteenth century arrived with advanced radical opinions and how sharp the social conflict was in the period of the great millionaires after the Civil War Here, we might think, was an ideal powder-barrel, ready to blow up at the first application of a match. But it has not. Though the United States owes more than any other country to the practical application of mechanics, and has won its successes with a good deal of strain and trouble, it has remained remarkably faithful to its fundamental assumptions of what American life ought to be.

Engineering and Social Stability

If, as we well may, we regard politics as the struggle for power, engineering is not a political activity. It aims at something quite different—the control and exploitation of natural resources to give a greater degree of human welfare. It becomes political only when its very existence is threatened by authority, and that may have been common enough in the past but seems less and less likely to be common now, or when it is taken up by authority for its own ends. In itself it stands outside and beyond politics, and the outlook which it represents is essentially non-political, and if we wish to know what it means for society, we must not look at it entirely or even mainly from a political angle. It embodies in the first place a special outlook, which is that man's struggle for existence cannot merely be maintained by exploiting natural resources but can even be made progressively less laborious as knowledge of their control increases. This is not a Utopian dream, not another form of the old wish to regain a lost Paradise or to return to a Golden Age. It can call as witnesses to its realistic good sense its own achievements and show that these have indeed done something beyond reckoning to ameliorate the human lot and positively to improve it. It is all very well to look back with regret to the age of the Antonines or of Louis XIV or even of George III, but I am very suspicious of this particular brand of intellectual opium. I would not deny that our own century has had its appalling catastrophes, but I would confidently assert that life is more agreeable now for the mass of mankind than it has ever been, and that this is almost entirely due to man's increasing conquest of nature through machines. Agreeableness may not be everything, and not even a final test, but it is, after all, something, and this at least we owe to the engineers.

The engineer works within his own social frame, and as the modern world is organised into national states, his work has to be shaped to suit them and their demands. Within these limits his work is a strong stabilising influence. On the one hand it avoids the angry discontent which is inevitable when no change seems possible, and on the other the complacency which assumes that everything is, after all, as good as it can be and that nothing need be done about it. Unlike the fine arts, which are always having to make a fresh start because something has been done so well that it cannot be done again, it moves in an ordered progress in which every new step is a real advance and leads to others beyond it. Such a process satisfies both man's desire for order and stability and his love of novelty. He likes to think—and who shall blame him ?—that many new delights lie round the corner, but he shrinks from paying too heavy a price for them. Each new discovery has to be turned to practical use, brought into general circulation, and consolidated inside the social frame. This takes time and patience, but nobody denies that it is worth it. A society which has become accustomed to seeing its own life improved by many inventions will develop a rational approach to its problems, realise that stability is something almost beyond price and be very cautious of losing it.

This aspect of engineering is extremely relevant to the modern world. In the last forty years some 800 million people have passed through violent revolution which has destroyed the fabric of society in which their fathers lived. These revolutions have indeed been political in that they have transferred power from one class of people to another and have held out enormous promises of improved ways of living. Both in Russia and in China revolution has been followed by prodigious efforts to apply science to all kinds of life. Now in this there is undoubtedly an element of propaganda. When promises have been made, men will ask that they are kept, and the most sensible way of keeping revolutionary promises is to increase prosperity by engineering. Nobody will dispute the practical wisdom of Stalin or of Mao-tse-tung in telling their peoples that if they will only study the right technology, all will in the end be well and the rapturous hopes of their youth fulfilled. But this element of worldly wisdom is matched by another. The governing classes of revolutionary states may have come to power by violence, but the last thing they want is that this violence should continue and be turned against them. They see that if they can only induce a proper respect for engineering, their subjects will realise that conditions can indeed be improved and will put up with a good deal of discipline and regimentation in the hope that in the end they will be better off. They are wiser in their generation than the later Emperors of Rome or the Manchu Emperors of China, since they see that, though men can indeed feed on hopes for a long period, sooner or later these hopes must be turned into something more substantial.

If we could believe in progress with the happy optimism of the nineteenth century, we might well think that the increasing command of mechanics would inevitably lead to the greater happiness of mankind. In principle there is no reason why it should not, but our own age has issued too many warnings against vaulting hopes for us to be able to believe it. It has learnt to its cost that mechanical progress can too easily be defeated by political insanity and that just because engineers are confined to their own social and national systems, they can do little or nothing to prevent it. Though our own century has made technical advances quite as great as those of the nineteenth, it has not enjoyed that prolonged peace which Great Britain enjoyed from 1815 to 1900 or that sense of security which is based on the belief that most social problems can in the end be solved by a more generous distribution of material goods. Both international war and class-war have dominated and damaged our lives despite the obvious increase in

most countries of prosperity and ease. For this we must blame man in his capacity of a political animal. He has failed to evolve means by which his desire for security and prosperity can be combined with other darker and less rational forces in his nature. We cannot but ask whether engineers must not to some degree bear the blame for this, whether they have not, albeit unwittingly or unwillingly, sharpened these conflicts and made them more deadly.

In a fair judgment, if the engineers are to blame at all, it is for sins of omission rather than of commission. I would not deny that they have created weapons of destruction such as our ancestors never dreamed of, but at least it can be said on their behalf that in this they were the agents and the servants of political power, that it was not, after all, their own ambition to fashion instruments which may blow up the world. The blame for this lies with the mass of men who insist upon destroying each other. Where the engineers have gone wrong is perhaps in taking too modest a view of their own task and their own duties. They have set out, in all sincerity and decency, to improve the human lot, and they have assumed, reasonably enough if the world were reasonable, that this means a greater exploitation of natural resources for the general benefit of humanity. But this, unfortunately, is not always what humanity asks for. When, for instance, we look back to 1914 and see how prosperous Germany was, how rapid were her advances in all branches of applied science, how doctors of engineering from the Technische Hochschule at Charlottenberg seemed to have before them the whole wide world from the Rhine to the Yangtse, we must surely be amazed not only that the Germans insisted upon going to war but that they acted in a spirit which denied and rejected the good things which were already theirs so abundantly. It is impossible to read the German literature of the age of William II without seeing how many serious and high-minded Germans desired war as a protest against what they thought to be the enfeebling, unmanly influence of peace. Nor was this spirit confined to Germany. It was hardly less obvious in England where young men like Rupert Brooke went gaily to their dooms in the conviction that they were getting away from a scheme of life which stifled their best impulses and placed far too much emphasis on comfort and security. This spirit was indeed to perish in the blood-baths of the Somme and Paschendaele, and an angry reaction set in against it. But it is never very far from the surface and has asserted itself again more than once in more brutal and less romantic forms. While the engineers labour to make life easier and more agreeable, the mass of men accepts their contribution for a time and then, in wild frenzies of unreason, rejects it and destroys it.

For this I can see no cure. It is not easy to find an emotional equivalent to war for those who like war, or at least like to send others to it. But if what is wanted is excitement, if what some men resent in ordered society is that it is too dull, there can be no doubt that engineering can offer them thrills in plenty. The conquest of the air, which we now take almost for granted, has provided not only problems to be solved at the highest intellectual level, but the practical application of their solutions with a confidence which is the modern equivalent of heroic courage. The conquest of famine and drought by the proper control of water supplies calls for generalship at the top and consummate discipline and skill among the other ranks. The exploitation of new sources of power calls both for strategy and for tactics in many unfamiliar corners of the globe and evokes visions of advances over enormous fronts. Engineering, more perhaps than any other branch of human activity, provides an imaginative equivalent to war, and has the advantage that it creates instead of destroying. Whether mankind will learn this in time is perhaps too much to ask. But let us at least indulge in a faint and pious hope that it will.

If it is true that some men find a well-organised and well-mechanised life so dull that their only release is violence, we can at least say that it is their own fault and that they have only themselves to blame. For to be bored to this degree is surely a terrible failure in oneself. But there are more subtle and more specious criticisms than this against the growing part which engineering plays in the world, and especially against the almost incredible increase of speed in communications which we have seen in our own lifetime.

When I was a boy I rightly thought it wonderfully exciting to travel from London to Peking by Siberia in a fortnight; how different from the six or more weeks by sea. But now a fortnight seems far too long for a journey to anywhere except to the moon. To the man for whom travel is a means to something else this increase of speed is, of course, a blessing. He wastes far less of his time than before in getting from one place to another. Yet we may perhaps wonder whether this change in the whole character of communications has not been bought at rather too heavy a price.

(To be concluded)

Special Turbine for High-Speed Running

By R. C. McLEOD, A.C.G.I., M.I.Mech.E.*

The design of a high-speed turbine required for a special duty is discussed here. The turbine in question was required for a maximum running speed of 12,500 r.p.m. and a maximum power of 15,000 h.p. Originally it was expected that the highest power taken from the turbine would be at high speeds, but, as the machine was nearing completion, it became known that it was likely to be used at quite low speeds with a very large torque. The influence of these unusual operating conditions on the design of the turbine is considered in this article.

IT is seventy years since Parsons first showed the world that a steam turbine was a practical possibility; since its introduction, it has been developed in many countries, mainly in the direction of providing a means of driving electrical machines and ships. In its early days, the design of the turbine was much hampered by the low speed requirements of ships' propellers, and it was not until reduction gears became available that turbine speeds could be made more consistent with the thermodynamic requirements of a steam turbine.

In the field of electrical generation, powers and speeds in relation to powers have continued to increase, but speeds have had to be related to the electrical machine. Since the disappearance of the large range of a.c. frequencies which existed in the early part of this century, the speeds in use now are 1500, 1800, 3000 and 3600 r.p.m. Unless the plant is small enough to be geared, the speed must be limited to 3000 or 3600 r.p.m. Even when gears are used, steam conditions often make possible a higher turbine speed than can comfortably be transmitted by a gear.

There are a few applications for turbines which call for speeds very much higher than those usually met, and some of these duties require powers which are high in relation to the speed. The turbine described below has been made by the Brush Electrical Engineering Company, Ltd., for one of these relatively rare applications; its maximum running speed is 12,500 r.p.m. and its power is 15,000 h.p. The boilers, which drive the turbine, existed before the order was placed with the Brush Company; there was therefore no choice of steam pressure.

With the speed specified, it is evident that the diameter of the turbine and the maximum blade length are controlled by considerations of stress, and the annular area for passing the exhaust steam becomes limiting if an attempt is made to work with an exhaust pressure which is too low.

For an increase in exhaust pressure, there is a reduction of heat drop, with a consequent increase in steam flow for a given power, and this tends to start a vicious circle, if the steam inlet pressure is below a certain figure. With the steam pressure available (in this case 350 lb per square inch) an exhaust pressure of 10 lb per square inch absolute results in satisfactory compromise of acceptable stress and axial leaving velocity. Any improvement which can be made in blading efficiency has a double effect, because a reduction of steam flow makes possible a lower exhaust pressure, which itself reduces the steam flow. With this in view, a serious attempt has been made to attain the highest efficiency possible. The turbine is a double-flow machine with a constant blade root diameter of 12in and there are nine stages in each flow. The first row of blades has a height of 0·7in and the blades in the last row are 3·1in long. The stage heat drops and blade profiles have been arranged so that the blade tips lie in a conical envelope, which simplifies the boring of the turbine casing. The blades, which are unshrouded, are of a modified vortex design shaped in such a way that radial flow is reduced to a minimum. At the high-pressure end, the blades have 15 to 20 per cent reaction at the roots with reaction at the tip depending on the blade length.

As the low pressure end is approached, the reaction at the roots increases and the blades of the last stage have 37 per cent reaction at the root with 65 per cent at the tip. At the high-pressure end the blade tip clearance is 0·025 and at the low-pressure end it is 0·04.

A sectional arrangement of the turbine faces page 436. The two rotors are rigidly connected together by a short connecting shaft which acts as the centre journal; each side of the journal there is a thrust collar associated with a set of Michell thrust pads. The centre bearing housing is kine-

* Designer of Axial Flow Turbines, Brush Electrical Engineering Company, Ltd.

matically mounted between the two exhaust ends giving the latter freedom to expand without changing the bearing alignment. The surfaces of the housing which bear against the corresponding seatings on the exhaust ends are spring loaded with the object of preventing "fretting" while, at the same time, there is freedom to slide without excessive loads due to friction.

The two exhaust ends, which are of cast steel welded together, are carried by resilient steel plates constraining them in every direction except radially. The turbine cylinders have integral overspeed trip valve bodies, and their high-pressure ends are carried by paws which rest on brackets cast on the high-pressure bearing housings. The paws are pressed on to the brackets by springs in addition to the weight of the turbine. Sideways location of the cylinders is provided by central keyways which engage keys fixed to the bearing housings. In addition to the spring loading arrangements for the centre bearing housing and the paws, there are keeps, which prevent a separation of the surfaces by more than 0·002in in the event of a spring failure. The high-pressure end bearing housings, which are of cast steel, are rigidly bolted to the fabricated base plate.

The two high-pressure bearing housings are similar, but some of the accessories attached to them are dissimilar. Both ends contain a train of double reduction gears and both are fitted with overspeed trip rings. One end is fitted with a further train of gears driving two small alternators for working remote tachometers, the opposite end is fitted with a hydraulic (or more correctly oleo) overspeed trip which can be set to trip the turbine at any speed while it is running. This is necessary because the machine being driven by the turbine may have a lower safe maximum speed than the turbine. The variable overspeed trip consists of an oil pump of the gear type driven by the turbine; it takes its oil from a small service tank and returns it to the same tank through an adjustable needle valve. To remove heat from the oil due to the work done by the oil pump, the oil in the service tank is allowed to overflow into the main tank while a small supply is fed to it continuously. This valve which is remote from the turbine can be set to any opening by the turbine driver. When the oil pressure upstream of the needle valve reaches 100 lb per square inch it lifts a diaphragm against a fixed spring pressure and opens an electric circuit. It should be stated here that the trip valves of the turbine can only be set in the open position when the electric circuit is closed. The electric circuit is used to energise solenoids which lift their plungers against the resistance of tension springs. When the circuit is broken, the plungers are pulled out by the springs, and a trigger is struck which causes the trip valves to close. A number of other devices in series with the same electric circuit cause the turbine to trip for the following reasons: low oil pressure, high water level in condenser and insufficient vacuum; and certain other safety measures are included.

The trip valves themselves are single-seated unbalanced valves. When released they are closed by the combined forces of a compression spring, the steam pressure acting on the valve spindle area and the pressure drop through the valve acting on its area. The valves are held in the open position by oil pressure which acts on discs whose peripheral faces are held on to seats when the valves are in the open position. Collapse of the oil pressure allows the valves to close, which they do very quickly. The disc arrangement gives much quicker closing than is possible when a piston is used, because when it is off its seat, it can move within the oil without having to accelerate a column of oil in a pipe. The downstream sides of the discs are drained back to the oil tanks and the upstream sides are connected together. Oil is fed into the pipe connecting them through a light non-return disc valve having a small hole in it. The non-return valve closes when oil is being fed to the chambers containing the discs, the oil can thus enter through the small hole. This has been done to limit the amount of oil which would otherwise flow to drain. When oil is being released from the chambers, the non-return valve can open and give the full pipe area. When the oil pressure is applied to the non-return valve, the main trip valves are set by pressing the two spherical-ended spindles apart. To do this, an appliance is used which might be described as "negative scissors." When the handles are pressed together the "scissors points" move outwards. The "scissors" points are cupped to receive the spherical spindle ends. In setting the valves open, the "scissor" handles are pressed together and held there for a few seconds so that the incoming oil has time to build up pressure. At the top of the disc chambers there are $\frac{1}{16}$in holes connecting the pressure sides with the drain sides; these holes are to prevent the possible accumulation of air bubbles which would re-expand on the release of oil pressure and slow down the rate of pressure collapse. The spherical-ended setting spindles have valve heads inside the disc chambers which are held against seats by the internal oil pressure when not actually in the process of setting the valves. By connecting the disc chambers together, it is impossible for one valve to be set unless the other is set also; whichever valve trips first must deprive the other of oil pressure.

The valve seats of the trip valves are masked; at the time when the valve enters the mask, the disc enters the conical end of the chamber, the trapped oil then cushions the final closing of the valve.

The oil which holds the valves open is controlled by piston type pilot valves, which when "up" allow oil to enter the disc chambers, and when "down" connect the disc chambers to drain, cutting off the oil supply at the same time. Compression springs hold them in the "down" position and when set in the "up" position the action of the springs is opposed by detents. The detents can be released either by the overspeed trip rings coming out, or by opening the solenoid circuit. The two pilot valves are in series, so that either one can trip both steam valves.

The machines to be driven by the turbine may be required to run at any speed from about 4000 r.p.m. to 12,500 r.p.m.; the powers may be as low as 1000 h.p. or as high as 15,000 h.p. Steam to meet any of these needs must obviously be controlled. It would be difficult, but not impossible, to make a governor to meet these requirements, but for the sake of simplicity the users are content to control the speed by hand.

The steam pipe feeding the turbine is 10in diameter and a valve for accurate control of the steam flow would not be easy to work by hand. The steam is controlled by a double-beat valve having profiles designed to give gradual opening, it is operated by a conventional oil relay using a floating lever and pilot valve. The point of the floating lever which would normally be connected to the governor is connected to a nut and screw mechanism which is remotely operated by hand. To eliminate all backlash the linkage is spring loaded.

The driven machines may be designed to run either clockwise or anti-clockwise and, to meet this requirement, it is possible to take power from either end of the turbine The driven machine is not connected directly to the turbine shaft, but through a floating shaft which drives one end of an axially-resilient shaft; the latter is enclosed in a robust cast steel housing. There are two reasons for this arrangement, the first is that the driven machine may under certain conditions exert an axial thrust of 10,000 lb, which may be in either direction. The second reason is that the driven machine is frequently highly stressed and to some extent liable to mechanical failure. It is hoped that by placing a "buffer state" between the turbine and the load that damage to the turbine may be minimised or eliminated. It would be undesirable to subject the turbine's thrust bearing to a load of 10,000 lb, and to overcome this the housing which contains the resilient shaft also contains a separate thrust bearing, which has been made as large as the speed would allow without undue heating due to the rate of oil shear. This thrust bearing is next to the driven machine; the axially resilient shaft between it and the turbine deals with the shaft expansion of the turbine, which, as stated earlier, is located by thrust collars between the two exhaust ends.

On the conical ends of the turbine rotors internally toothed couplings are fitted, which give sufficient flexibility to allow the floating shafts to float, but couplings of this kind could not be relied upon to provide freedom for shaft expansion. The friction due to the large torque could easily transmit large axial thrusts through the coupling.

The illustrations facing page 436 include a section through the resilient shaft consisting of eight discs, which are made as thin as possible. To provide lateral stiffness the two centre discs are integral with the tubular shaft which is carried at the ends in cast iron rings; these are lubricated and capable of replacement if "fretting" takes place. The stresses in the discs must necessarily be considerable if they are made thin enough to flex and the possibility of fatigue cannot be ignored. To guard against the effects of this, the outer discs have internal teeth cut in them, and the tubular shaft has external teeth cut on the ends. These teeth are not in contact and, in fact, have a clearance of 0·02in. Should any of the discs fail the drive would be taken up by the teeth and overspeeding of the turbine would be prevented.

Because of the low weight of the turbine rotors in relation to the power, the acceleration can be extremely rapid. As an indication of what this means, the full steam flow could accelerate the turbine from a standing start to 12,500 r.p.m. within two seconds.

With the central location of the two turbine rotors each rotor expands towards the respective high-pressure end. The turbine casing also is located axially at the centre by the radially resilient steel plates. The difference in mass between the casing and rotor naturally causes an unequal heating rate, and relative axial displacement must occur between the rotor and casing at the high-pressure end.

The certainty of relative axial displacement is the reason why non-shrouded blades are used. Shrouded blades with "end tightening" would need larger clearances than are necessary with "tip tightening." For the same reason the labyrinths at the high-pressure ends are non-interleaving. The

steam leaked off from the labyrinths is led directly to the condenser through automatic valves, which prevent the outer parts of the glands from being subjected to sub-atmospheric pressures. For pressure equalisation the two steam belts are connected by a balance pipe.

The description of the turbine would not be complete without giving a few details about the turbine rotors. The variety of speeds likely to be encountered makes shaft critical speeds in the running range unacceptable. Originally an attempt was made to design a rotor having discs at the high-pressure end with a drum construction at the low-pressure end. It was found that the stiffness required for keeping the first critical speed out of range led to a shaft which was so fat that the discs became vestigial ; it was therefore decided to make the rotor as a drum.

The relatively large power being obtained from such a small turbine made it advisable to make the blades as robust as possible, and as the value of $\omega^2 r$ in this turbine is higher than usual, adequate blade roots are necessary. The blades and their roots are therefore somewhat heavy towards the l.p. end and load the rotor considerably. By the usual elastic theory this gives a tangential stress at the bore of the rotor of 22·5 tons per square inch. The mean tangential stress is 11·8 tons per square inch. The material used is a chrome manganese molybdenum steel having a yield of 58 tons and ultimate of 64 tons, elongation 15·5 per cent, reduction of area 42 per cent.

The blades are secured by circumferential " fir tree " serrations ; they are entered at a gate and driven round in the usual manner. The main point of interest is in the blade which closes the gate ; this has a positive attachment without using caulking for carrying loads. With this arrangement normal blade pitches can be used in the region of the gate, and examination of the illustrations will show that there is nothing to indicate which is the last blade.

As explained at the beginning of this article, the blades are designed for a modified form of vortex flow. It was also stated that the exhaust steam density had to be made high enough to obtain the necessary steam flow without involving the use of long blades. Even with an exhaust pressure of 10 lb per square inch absolute the mean axial velocity is nearly 900ft per second.

In the preliminary design the axial velocity of the steam leaving the blades was intended to be 900ft per second at all radii. As the design proceeded it was found that, from the mechanical point of view, a better blade could be designed if the axial velocity at the root was lower than at the tip. By so doing a larger cross-section could be used at the root, and it could be given more camber ; the resulting blade has a stiff root section and a light tip section. The " leaning " axial velocity profile characteristic of the last stage appears also, but to a progressively less extent, in the stages before it, and vanishes at the fourth stage.

The lubrication system is quite straightforward ; an electric motor-driven oil pump draws from a main tank in the basement and delivers oil at the relay pressure to a spring-loaded valve, by which the relay pressure is maintained. After this valve the oil enters the oil cooler, from whence it is fed to the bus pipe, from which all bearing feeds are taken. The outlet from the oil cooler is also led to a closed tank on the roof of the building. The gravity head from this tank is not quite enough to give the necessary oil pressure for full-speed running, and so the tank works under a slight pressure. At the top of the tank there is an air outlet valve, which is closed by a float when the tank is full. There is also a snifting valve to allow air to enter the tank when oil is leaving it. As the main oil pump is electrically driven, power failure could cause serious damage to the turbine if no provision was made to guard against this contingency. The roof tank provides an oil supply which lasts for three minutes. Failure of the oil relay pressure causes immediate tripping of the turbine. In the three-minute interval, which is often enough for the turbine to come to rest, there is ample time for the steam turbine-driven auxiliary pump to come into operation.

The condenser is rigidly connected to the turbine by a trunk, and its empty weight is supported by springs. The weight of water in the water boxes and tubes is carried from the turbine exhaust. The steam inlet branch on the condenser is not in the centre of the distance between the tube plates, but is disposed in such a way that as nearly as possible the weight of cooling water in the condenser applies a direct tension load, without a bending moment, to the turbine exhaust. A condenser to work with 10in vacuum implies a degree of vertical expansion larger than usual; for this reason the rate of the supporting springs has been made as low as possible. At the bottom of the condenser, on the vertical centre line through the turbine exhaust, is a point of constraint which allows vertical movement only. To ensure that the movement of the condenser up and down takes place with its axis horizontal at all times, the supporting feet of the condenser (on which the springs act) are connected by links through cranks on two torque tubes. Between the brackets on which the spring boxes rest there is a large-diameter torque tube at each side of the condenser ; these tubes are mounted in bearings at each end and have short cranks at each end. The cranks are connected by links to the corresponding feet above them ; on each side one of the links is adjustable. By the kinematic method used for supporting and locating the condenser the turbine is subjected to vertical loads only and these are transmitted to the side plates which carry the turbine exhaust.

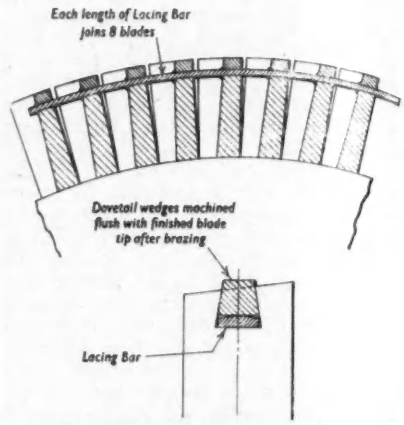
Owing to the small size of the turbine (the blade root diameter being only 12in) the 10in steam pipe cannot be connected to it in a casual manner ; here again kinematic principles have been applied and by so doing the loads and moments transmitted to the turbine are reduced to an absolute minimum.

At the time when the turbine was ordered, it was expected that the highest powers taken from it would be at high speeds. However, as it approached completion, there was an indication that it was likely to be used at quite low speeds with a very large torque. The robustness of the blades, paradoxically, led to some anxiety about their ability to withstand this duty. Owing to their stiffness their natural frequency was very high, and at low speeds the product of revolutions per minute and the number of nozzles corresponded with the fundamental frequency. There was therefore a dangerous speed for each stage at the high-pressure end of the turbine. As stated earlier, the blades are all unshrouded, and they were therefore free to vibrate as individual cantilevers, when excited with their resonant frequencies.

At the low-pressure end of the turbine, the blade frequencies are such that they can only receive resonant impulses at speeds which are so low that a high torque is not expected, consequently trouble with these blades was not considered to be so likely.

Possible resonance on the first row of blades was overcome by reducing the number of nozzles in that stage ; by so doing, the speed at which resonance could take place was raised to a figure above the maximum running speed. For stages 2, 3, 4 and 5 the possibility of resonance could not be ruled out but, as the turbine was required for service it was decided to use it until something happened. After a period of heavy work at speeds in the region of the resonant one for stage 4, a blade broke off, fortunately without doing any serious damage. When the remaining stage 4 blades were removed from both ends, it was found that a large number of them had fatigue cracks. After the removal of all the stage 4 blades, the remaining blades were subjected to magnetic crack tests ; all were intact. Two new sets of stage 4 blades were put in hand using a stronger material.

Obviously something had to be done to minimise the possibility of further trouble due to blade resonance. As the number of blades in each of the first four stages was ninety-six, and the number of nozzles was rather less than half this number, there seemed to be a good prospect of making the impulse on one blade cancel the impulses on the adjacent ones, because when they are free


Each length of Lacing Bar joins 8 blades
Dovetail wedges machined flush with finished blade tip after brazing
Lacing Bar

Method of lacing tips in stages 2 to 6 of rotor to cure blade resonance troubles

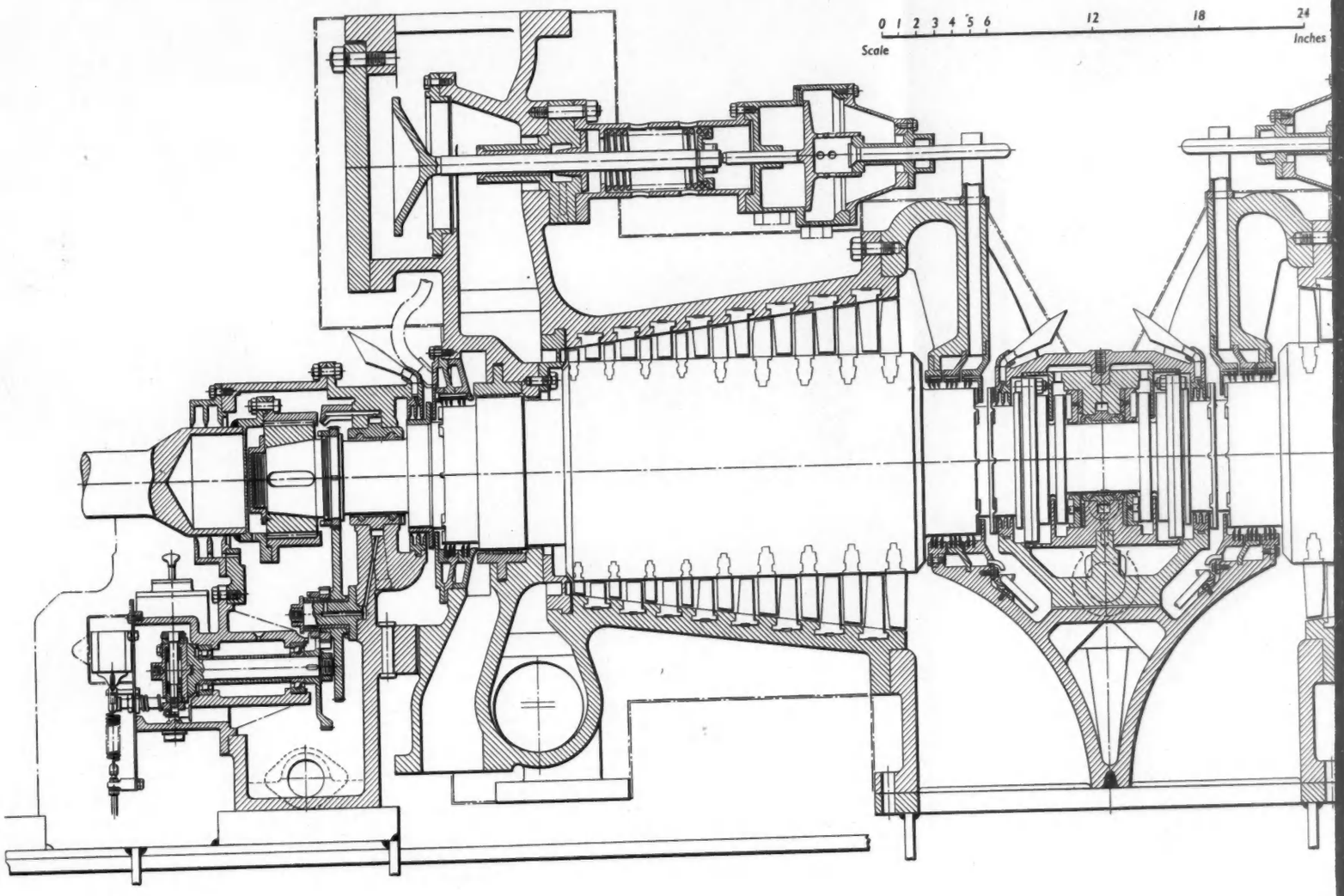
cantilevers, their vibrations are out of phase with each other. By connecting the blades with tension members as near to their tips as possible, the impulses could be passed from blade to blade. A group of blades so connected is subjected to a nearly constant total load, there is therefore far less tendency for them to vibrate.

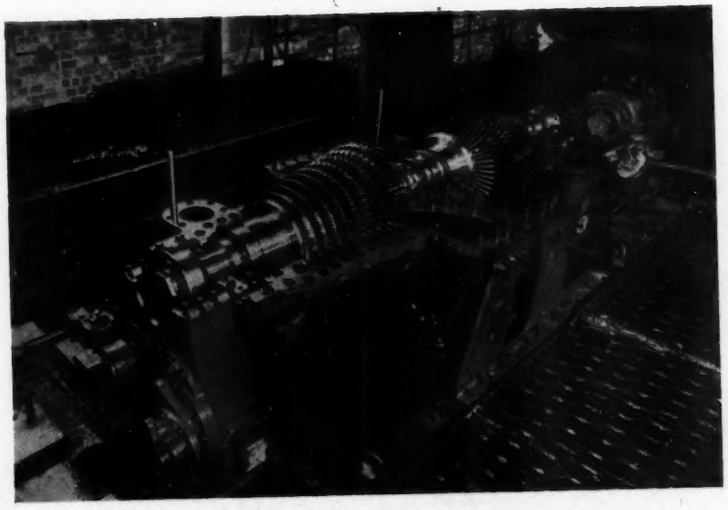
It was desirable, if possible, to devise a means for connecting the blade so that it could be fitted to those already in the rotor ; it also had to cause the minimum obstruction to the steam flow. Finally, it had to be strong enough for its work. After considering various alternatives, the arrangement shown above was adopted. The tips of the blades had a dovetail groove turned in them and a strip of " Staybrite " was inserted at the bottom of the groove, a dovetail-shaped filler piece standing proud of the blade tip was then forced in on top of the strip. The whole assembly was finally brazed, and the proud filler pieces turned flush with the blade tips. The result of this operation is illustrated opposite.

At the point on the blades where the strips are fitted, there is vigorous accelerating flow, and the strips present a rounded edge to the direction of flow. It is not known how much loss the modification has introduced, but no falling off in performance has been detected, and so far the turbine has been free from further blade trouble in spite of much hard work.

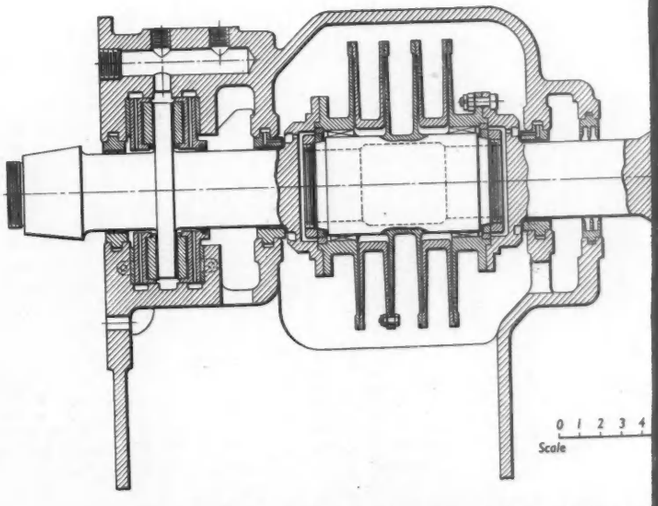
SPECIAL PURPOSE 15,000 B.H.P., 12,500 R.P.M

STEAM INLET: 350 LB PER SQUARE INCH AT 650 DEG. FAH. EXHAUST: 10





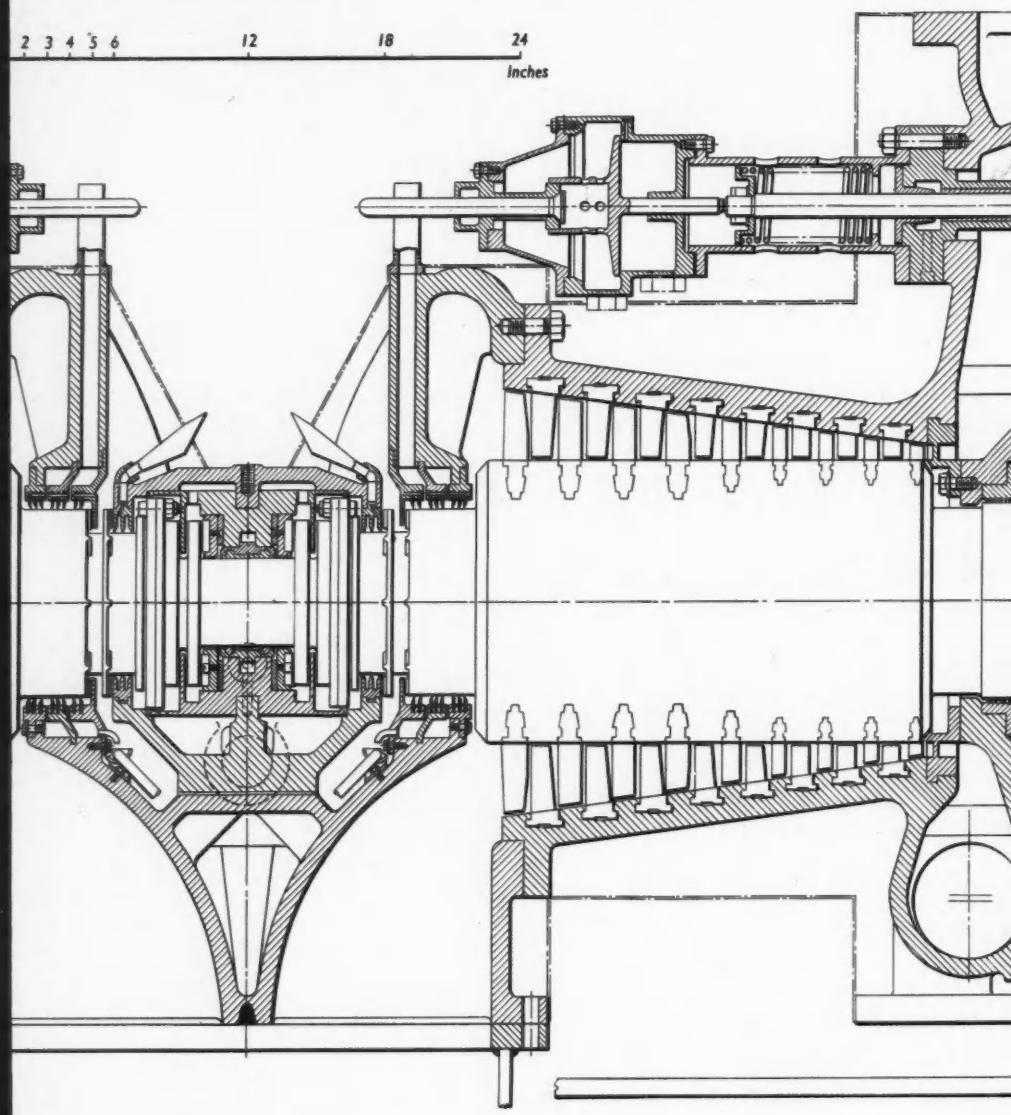
Rotor and lower half casing of 12,500 r.p.m. steam turbine

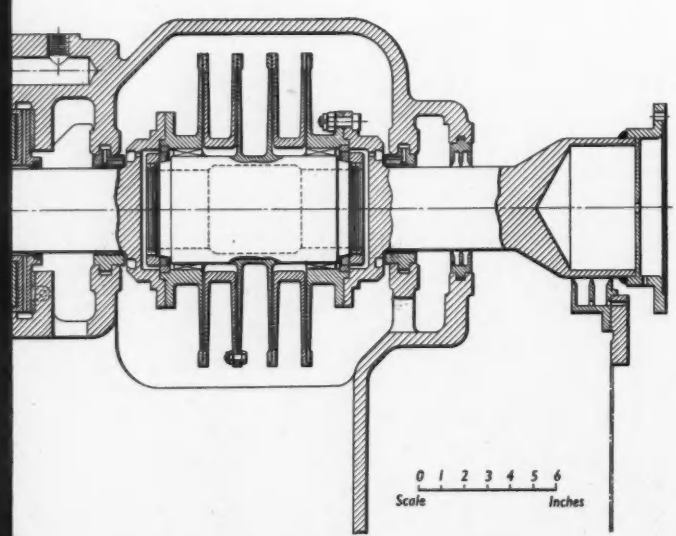


Outer thrust bearing and resilient coupling of 15,000 b.h.p., 12,500 r.p.m.

00 B.H.P., 12,500 R.P.M. STEAM TURBI

PER SQUARE INCH AT 650 DEG. FAH. EXHAUST : 10 IN HG VACUUM

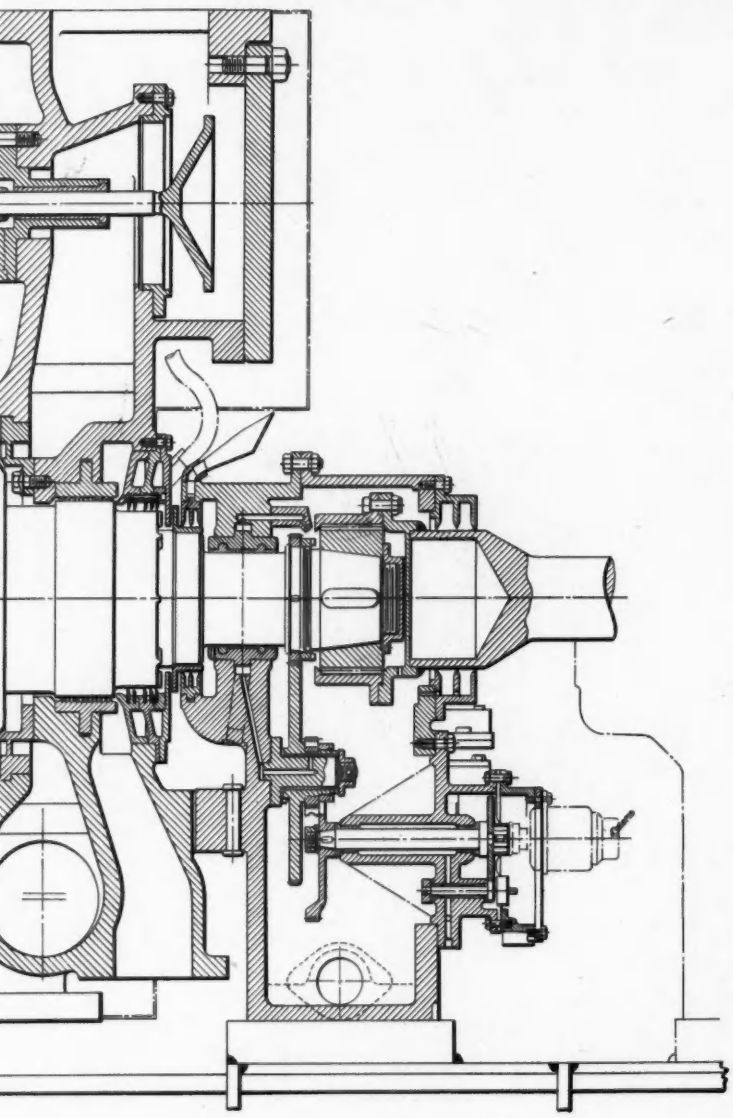


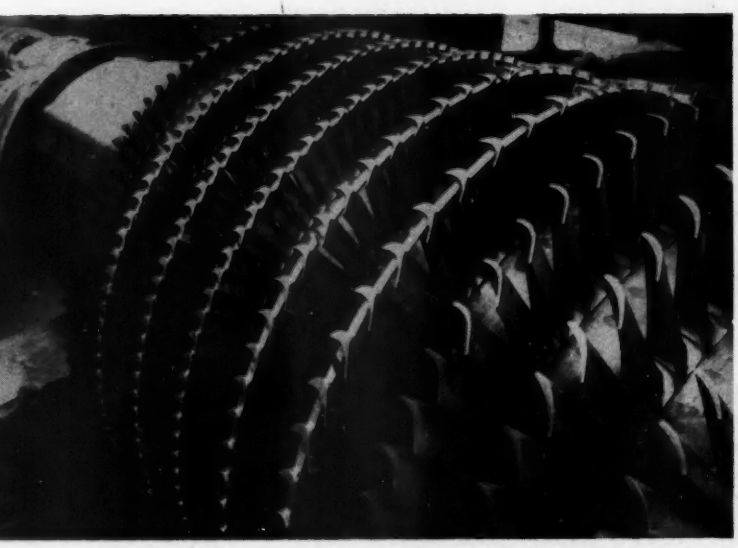


st bearing and resilient coupling of 15,000 b.h.p., 12,500 r.p.m. turbine

Lacing

RBINE





Lacing of tips of blades on rows 2 to 6 to eliminate blade vibration troubles

British Industries Fair

No. III—(*Concluded from page 402, April 27th*)

THE British Industries Fair at Castle Bromwich, Birmingham and Olympia, London, closes to-day. We conclude our review of the engineering section with some further notes about the exhibits.

Lansing Bagnall, Ltd.

The materials handling plant shown in operation on the stand of Lansing Bagnall, Ltd., Basingstoke, Hants, includes a new fork truck designed to handle 40in by 40in pallets in 5ft 6in circles. It is designed to lift and stack loads of up to 2500 lb to a height of 10ft, and can be seen in operation in Fig. 23.

On the new machine the complete fork and mast assembly is mounted on a bracket

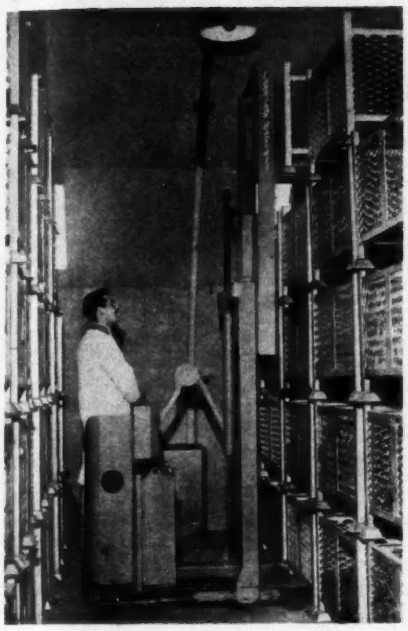


Fig. 23—Fork truck with a capacity of 2500 lb and designed to work in 5ft 6in aisles—Lansing Bagnall, Ltd.

carried on rollers and slidable along the main channel-section base frame members of the chassis. During travelling and manœuvring of the machine the assembly is retracted to bring the forks and load back within the wheelbase. When stacking the assembly is extended to bring the forks into a position they would normally occupy on a conventional machine. This "reach" travel is just over 32in. Less than half of the truck's overall length of 58in is occupied by the compactly arranged batteries, power unit and controls. The operator has a convenient stand-on recessed driving position from which he has a clear view and ready control of all operations. To give an unobstructed view of the load the fork lifting and lowering ram is set to one side of the mast of the machine.

The number of controls used for the machine has been kept to the minimum. A single lever controls the speeds of raising and lowering, and forward and reverse travelling up to 5 miles an hour. A separate lever is operated for extending or retracting the mast along the chassis, and steering is effected by a horizontally mounted wheel arranged for single-handed operation. A pedal brake on the operator's platform is automatically applied when the foot is removed, and the machine is fitted with regenerative braking which comes into effect on downhill runs. An interlock prevents the truck being moved at speed when the mast is extended and all controls move to the off position when released.

W. Canning and Co., Ltd.

The materials and equipment for electroplating and polishing shown by W. Canning and Co., Ltd., Great Hampton Street, Birmingham, cover processes applicable to all types of metals. The main exhibit is a bright nickel plating installation which includes a vat complete with rods and connections, together with a filter unit and heat exchanger. This installation is illustrated in Fig. 25, and as can be seen, the filter and heat exchanger situated at one end are coupled directly to the plant.

With the heat exchanger steam or high pressure hot water is used to heat the plating solution as it passes through the exchanger in a contraflow system, to give a high rate of heat input. No metallic parts are in contact with the solution and the risk of contamination is virtually eliminated. The heat exchanger equipment is arranged in the pressure filtration circuit outside the plating tank, and as no separate heating compartment is required in the vat the entire capacity of the tank is available for plating purposes. A range of heat exchangers is made to cover the requirements of tanks from 300 to 2500 gallons capacity.

A portable plating-out equipment also exhibited is designed to simplify the removal of metallic contamination from bright nickel plating solutions. If desired this equipment can be used whilst a tank is engaged on production plating. It is complete with rectifier, control gear, anodes and plating-out sheets, and it can be easily placed in position by one operator. This equipment is made in two sizes with current capacities of 25A and 50A respectively.

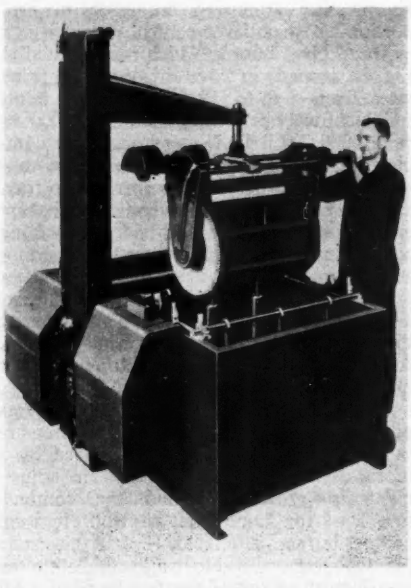


Fig. 24—Plating equipment with hydraulically operated barrel lifting gear—Canning

In Fig. 24 there is shown one of the firm's "Hymax" totally submerged plating barrel equipments in which a hydraulic system is used for raising and lowering the barrel in the tanks. The barrel driving gear is fixed at the rear of the tank and the barrel is rotated both in the plating and in the swill positions through the gearing incorporated in its support frame. The hard rubber barrel has a capacity of about 6 gallons and the

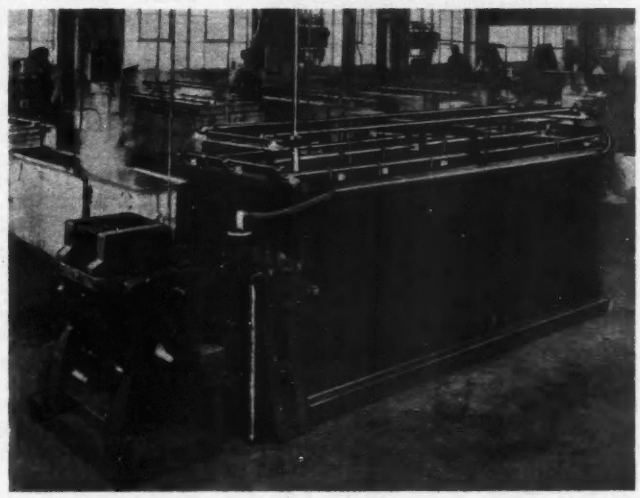


Fig. 25—Bright nickel plating installation with filter and heat exchanger equipment—Canning

equipment is suitable for most metals except hard chrome.

A 30in rotary table polishing machine on the stand has six chuck spindles and its "Follower" polishing heads are fitted with electrically-operated automatic polishing composition applicators. Components on chucks or mandrels are carried by the rotating table under a series of mops so arranged that all the surfaces of the articles are polished in one revolution of the table. A display of specimens on the stand show the finish obtainable with the firm's "Nimax" bright nickel plating solution.

Coventry Gauge and Tool Co., Ltd.

A new comparator for checking internally threaded components (Fig. 26) is being shown by the Coventry Gauge and Tool Co., Ltd., Coventry. It is simple in construction and is similar in principle to an expanding screw plug gauge, consisting of two master threaded gauging segments, the expansion or contraction of which actuates a sensitive dial indicator graduated in 0·0001in divisions. This dial indicator shows the relationship of the part being measured to a master setting ring. The gauging segments are mounted on two members which pivot on two hardened steel balls housed in conical seatings and held in position by tension springs. Movements of the segments are directly recorded on the dial indicator.

The comparator is operated by pressing together the two members, which in turn bring the gauging segments sufficiently close to each other to be inserted into the component. The spring-loaded members are then gently released and the segments engage

with the thread, at the same time actuating the indicator. Constancy of pressure against the threads is thus ensured, and renders experience unnecessary in judging an acceptable fit as when conventional gauging methods are employed. An eccentric contact pin actuates the dial indicator and enables the zero to be adjusted to the most convenient reading position.

The maker points out that as workpieces are not screwed on and off the gauging segments, wear on these parts is only slight even after long service, and compensation for moderate wear can be made by periodically resetting the master ring. The segments, which can be quickly interchanged to suit different components, and are positively located in the body of the comparator, are normally made in accordance with the requirements of "GO" Screw Plug Gauges B.S.S. 919, but if required pairs can be supplied for checking the effective diameter only. The normal range of the comparator is from ⅜in to 1in diameter (9·5mm to 25mm), but special segments can be supplied for fine threads down to ¼in (6·3mm) diameter. Models are available for either right or left-hand threads.

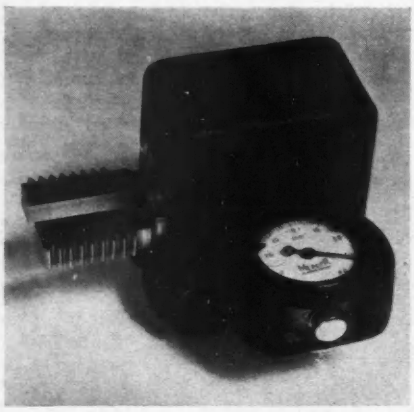


Fig. 26—Comparator for internally threaded components—Coventry Gauge

Conveyancer Fork Trucks, Ltd.

The latest development of the "E2-20" fork truck made by Conveyancer Fork Trucks, Ltd., Liverpool Road, Warrington,

Fig. 27—Battery fork truck of 2000 lb capacity at 20in load centre, fitted with a fork-carriage side shift attachment—Conveyancer

is the three-wheeled battery vehicle illustrated in Fig. 27. It has a capacity of 2000 lb at 20in load centre.

The truck is driven and steered by the single rear wheel, over which the traction motor is mounted vertically. The wheel can be turned through 90 deg. each side of the centre line, and with the independently rotating front wheels, this permits turning through 180 deg. from lock to lock.

Acceleration of the truck to top speed is governed at a safe value by an automatic timing device in the foot controller. For low speed working the truck can be run in any speed step, by depressing the pedal far enough to maintain that step. When the truck is running forward and the foot is removed from the accelerator, the forward/reverse control lever can be thrown over to reverse. On the accelerator pedal then being depressed the truck is brought to a standstill by power at a safe rate of deceleration. As soon as the truck comes to rest the foot controller comes into effect and the truck accelerates backwards under normal controlled acceleration, according to the setting of the accelerator pedal. The degree of dynamic braking is constant independent of the pressure on accelerator pedal and the control operates in the same way in both directions of travel.

Aerospray Associated, Ltd.

The comprehensive range of spray painting equipment demonstrated by Aerospray Associated, Ltd., 179–213, Thimble Mill Lane, Birmingham, 7, includes a new equipment for the application of plastics. It is of duplex design and provides a means of applying incompatible fluids—polyester and epoxy resins.

The equipment incorporates a 5 gallon capacity pressure-fed container to which there is attached a smaller container of about 1½ pints capacity. From these containers hoses are connected to the two separate heads of the duplex spray gun. This gun is designed to spray the materials through separate nozzles in such a way that mixing takes place some 4in from the head to give complete atomised mixing in the resulting spray pattern.

Nu-Way Heating Plants, Ltd.

Two examples of the new "ZH" automatic pressure jet burners for medium fuel oil are shown by Nu-Way Heating Plants, Ltd., Droitwich, together with sectioned examples of the "Rotavac" low air pressure atomising burners with proportioning single lever control.

The "ZH" burner, which is illustrated in Fig. 28, is made in three sizes covering firing rates from 1·9 to 17·5 gallons an hour, suitable for boiler ratings from 200,000 to over 2,000,000 B.Th.U. per hour. The complete burner assembly is mounted on a substantial base, which also forms a drip tray, and the electrical and mechanical units are grouped separately on each side. Incoming cold oil passes through a filter to a thermostatically controlled electrical pre-heater arranged across the front of the base. The heated oil is again filtered before passing through a pressure gauge to the burner head. An electric time delay is fitted to ensure that oil and air are mixed correctly upon starting; a magnetic valve in the oil supply line releases oil pressure on shut-off and delays pressure build-up on starting. Air is supplied by a motor-driven fan and primary air adjustment is provided behind the combustion head for flame front control. Ignition of the burner is effected by an electrode fitted in a removable block and coupled to the transformer on top of the fan housing. All the electrical connections are made through a terminal block at the rear of the fan housing and the transformer is isolated when the fan casing cover is raised.

In the new proportioning burners all the atomising air enters the burner through one

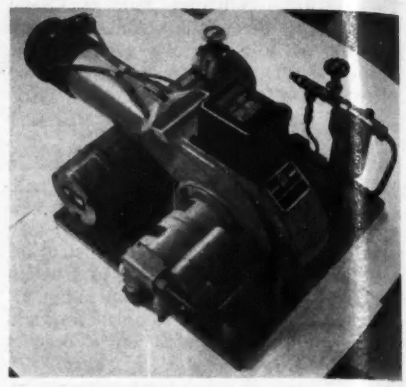


Fig. 28—Automatic burner for medium fuel oil—Nu-way

inlet connection and is controlled simultaneously with the oil by a single control lever.

Primary atomising air enters the inner air nozzle of the burner through tangential inlet openings, and this gives the air a rotary motion. As this air approaches the space round the oil nozzle with a maximum velocity it strikes and atomises the oil coming in from the supply orifices.

As this air-oil mixture leaves the inner air nozzle it is hit by secondary atomising air, delivered from an outer air nozzle opening, in a converging cone. This further atomises the oil, producing a burnable mixture of air and oil. When the air-oil control lever is moved towards the high flame position it moves the inner air nozzle back from the stationary outer nozzle, thereby simultaneously and uniformly increasing the air discharge areas of both nozzles and of a vee slot oil metering valve. Full atomising air pressure is always maintained inside the burner from high to low flame settings.

Ch. J. Newman, Ltd.

A new side-lever grease gun developed by Ch. J. Newman, Ltd., 445, Brighton Road, South Croydon, Surrey, is designed for filling with a grease "cartridge." By using this form of filling recharging is speeded, the messy nature of the operation is almost eliminated and danger of dirt being introduced in the gun is avoided. The grease cartridge consists of a tin with a lid at each end. To fill a gun the head is removed and the cartridge, with the lid removed from the inner end, is pushed in. The lid at the other end of the cartridge is then removed and the gun head screwed into position. The makers state that one cartridge contains sufficient grease for 300 grease shots, or sufficient for four complete greasings of all points on a motor-car.

Also on show is the firm's Mark 803 "Economy Lubricator," which can now be converted into a filler pump by simply inserting a filler valve adaptor between the handle body and hose assembly. Most side-lever grease guns are provided with either a plug or a filler nipple and to adapt the gun for automatic loading these are removed, and replaced by a special self-opening, self-sealing filler nipple. To load the grease gun this filler nipple is pushed into the filler valve and then one stroke of the pump handle fills the grease gun. By then depressing the filler valve sleeve the loaded gun can be safely withdrawn.

SIMON ENGINEERING (MIDLANDS), LTD.

A small model of the standard hydraulically-operated platform for overhead working is now being made by Simon Engineering (Midlands), Ltd., Queens Cross, Dudley, Worcs. It has a working height of 30ft and is being demonstrated at Castle Bromwich. This platform is constructed on

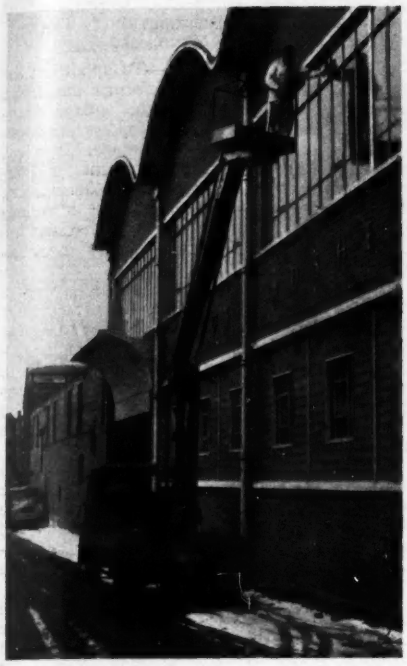


Fig. 29—Hydraulically operated platform for overhead working, with a maximum working height of 30ft and radius of 15½ft—Simon Engineering (Midlands), Ltd.

similar lines to the standard model described in our issue of May 20, 1955, but having a smaller working height and radius, it can be fitted to lighter vehicles.

The new equipment, to be seen in Fig. 29, has a maximum horizontal extension of 15ft 6in from the turntable centre to the front of the working platform, and with outrigger jacks in use the maximum platform load is 500 lb. All movements of the platform are hydraulically operated, and duplicate controls are fitted on the working platform and the turntable. Power for operating the equipment can be obtained either from the power take-off of the vehicle on which it is mounted or from an auxiliary 3 h.p. engine-driven pump.

The two booms through which the platform is supported and manœuvred are operated by 4in diameter, 2ft stroke, hydraulic cylinders, and the turntable is rotated by a hydraulic motor. A simple linkage maintains the platform in a horizontal position at any setting of the booms.

BROOK MOTORS, LTD.

Typical motors up to 600 h.p. are being shown at Castle Bromwich by Brook Motors, Ltd., Huddersfield. Among the smaller motors is the new "Merlin" fractional horsepower a.c. motor, designed for domestic appliances. The stator is a single $\frac{3}{16}$in shell with the core pressed in and locked in position. Detachable pressed-steel feet with slotted fixing holes are fixed to the stator by four bolts. The windings are of synthetic-resin-covered wire, interleaved with varnished cloth between coils and at cross-overs. The wound stators are immersed in insulating varnish and then baked. The rotor is of pressure-cast aluminium embedded in iron laminations and is dynamically balanced before assembly. White-metal sleeve bearings, with an oil-impregnated felt-packed cavity, are carried in the end shields, which are of cast iron or pressure die-cast aluminium, and the motor can be run with the shaft extension up, down or horizontal. The exterior finish is cellulose lacquer grey.

Split-phase starting is standard, the starting torque being 175 per cent of full-load torque and starting current six times full-load current. Capacitor starting and thermal cut-out protection are available as extras. There are three output sizes : $\frac{1}{6}$, $\frac{1}{4}$ and $\frac{1}{3}$ h.p. at full load speeds, in each case, of 1420 r.p.m. at 50 c/s or 1720 at 60 c/s.

The overall dimensions are : length, 10·406in.; height, 6·375in. For installation in washing machines or similar confined spaces the motor can be of reduced overall length, 9·906in, the height becoming 6·687in.

WESTINGHOUSE BRAKE AND SIGNAL COMPANY, LTD.

A working model of a mine-car propelling unit which has been developed for use in collieries is being shown at Castle Bromwich by Westinghouse Brake and Signal Company, Ltd., 82, York Way, King's Cross, London, N.1. This equipment is designed for moving heavy trains of mine cars at places where the locomotive has left them, to do other work. It consists essentially of two 8in diameter pneumatic rams, mounted side by side, with axle-pushing horns ; the two pistons work in opposite directions so that one is always pushing while the other is retracting to push again. The reciprocal movement of the unit maintains train movement until the last axle is beyond the reach of the unit.

Another interesting exhibit is the "Westculite" equipment—a new water-cooled rectifier which has been developed for electro-deposition and similar processes. The rectifier cabinet on show is designed for an output of 2000A at 8V. Other rectifier developments displayed on this stand include new contact-cooled rectifiers for the television industry and aluminium-based high-temperature units designed for operation in ambient temperatures up to 85 deg. Cent.

ELECTRIC CONSTRUCTION COMPANY, LTD.

A working model showing the principles of gas cleaning by electrical precipitation is being exhibited at Olympia by the Electric Construction Company, Ltd., Wolverhampton. The exhibit originates from the fact that this company is a contractor for the supply of electrical precipitation plant to W. C. Holmes and Co., Ltd., Huddersfield, and these two firms collaborated in building the model to illustrate the possibilities of cleaning gases by the removal of tar fogs, acid mists, cement dusts, p.f. boiler dust, ferric oxide fumes, and other particles.

The exhibits also include an electronically-controlled E.C.C. power unit for operating a pilot motor or induction regulator to provide automatic voltage regulation or speed control within ±1 per cent or better, by the use of a closed-loop servo system. The exhibit is shown supplying a dummy load to show its voltage regulation properties.

U.K. ATOMIC ENERGY AUTHORITY

One of the new models included in the United Kingdom Atomic Energy Authority's display at Olympia is of "LIDO," a research reactor which is being built at the Atomic Energy Research Establishment, Harwell. "LIDO" is a reactor specifically designed to enable shielding problems to be investigated. To keep down capital costs of mobile reactors and power station reactors it is important to minimise the size and weight of shielding and studies made with "LIDO" will be directed towards this end. "LIDO" is a thermal reactor using enriched uranium as fuel and light water as both moderator and coolant. The core is suspended in a tank of water from a trolley, whereby it can be moved to any part of the tank. Sufficient depth of water is maintained over the core to provide vertical shielding, and horizontal shielding is provided by the concrete walls of the tank. In two areas, one incorporating a corner of the tank, this concrete is cut away and replaced by aluminium "windows," which form the working faces so that experiments can be built up adjacent to them on the outside. When it is wished to make measurements the core can be moved closer to them on the inside. Experiments may also be assembled inside the tank : for this purpose the core can be moved into a small bay at one end of the tank and isolated from it by a water-tight door. "LIDO" is due to be completed towards the end of this year.

BRITISH THOMSON-HOUSTON COMPANY, LTD.

An infra-red relay equipment, which uses a lead-sulphide photo-conductive cell as the sensitive element and is capable of detecting a body at 400 deg. Cent. at a distance of 4ft, is shown at Olympia, by the British Thomson-Houston Company, Ltd., Rugby. A more sensitive equipment, stated to be capable (under ideal conditions) of detecting a hotplate at 80 deg. Cent. at the same distance, is also made by the same company. These relays were described and illustrated in our issue of November 18, 1955, page 733.

Amongst the switchgear on show is a new 3·3kV "AL.6" air-break equipment which has been tested for a short-circuit rating of 250MVA. The circuit breaker has high-pressure butt contacts with silver facing, designed with a heel and toe action so that current carrying and arcing duties are effectively accomplished with the one assembly. The arc is transferred to horns enclosed by arc-chutes which incorporate cooling assemblies to confine and cool the arc. An innovation is the inclusion of a selector switch in the moving portion interlocked with the circuit breaker operating mechanism. The lower set of isolating plugs form part of the switch and circuit isolation and earthing can be effected through the breaker without withdrawing the truck. The switch has three positions—"On bars," "Isolated" and "Earthed"—and is operated from the front of the truck by a remov-

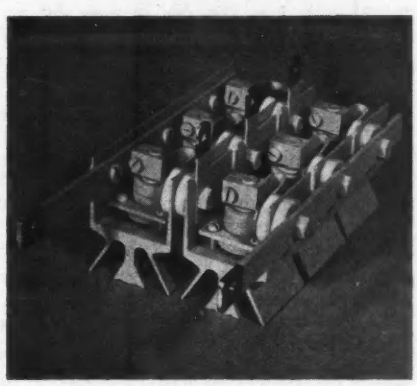


Fig. 30—Six silicon rectifier cells in a three-phase full-wave bridge assembly measuring less than 3in by 5in by 6in, including the cooling fins, with an output of 15kW—B.T.H.

able handle. The equipment is flush-fronted with a full-length swing door.

Germanium and silicon power rectifier assemblies for mounting in cubicles, together with the associated transformer, instruments and switchgear, are shown, together with two complete germanium rectifier cubicles. Two different mechanical arrangements of six germanium rectifier cells for operation in a three-phase, full-wave bridge formation are shown. Under naturally-cooled conditions, each assembly can give an output of 120A at 150V d.c. Similar cells are used in the two complete cubicles. One cubicle has an output of 5kW at 12–0–12V d.c. (208A), and the other has an output of 20kW, 12–0–12V at 835A. This latter equipment is forced-cooled and is housed in a cubicle only 3ft wide by 2ft 9in by 5ft high.

Silicon junction rectifiers operate with a slightly lower efficiency but they work satisfactorily at temperatures above 200 deg. Cent. and are therefore eminently suitable for operation in high ambient conditions. A single silicon cell is exhibited with a diameter of only 1¼in, having a rating of 50A (mean) at a working voltage of 100. Six silicon cells in a three-phase, full-wave bridge arrangement (Fig. 30) are shown with an output of 15kW. The assembly, complete with cooling fins, occupies a space of less than 3in by 5in by 6in.

F. H. BOURNER AND CO., LTD.

The "Coronation" hose clip is universal in the sense that a clip for any pipe diameter can be made from stock strip: thus the need to provide clips which vary only in their nominal diameter is obviated. The strip is of malleable steel, protected from corrosion by zinc coating and an overlying plastic dye. One end of the strip is passed through a slot in the underside of the housing and then bent back 180 deg. An eye bolt is inserted into the housing and the other end of the strip

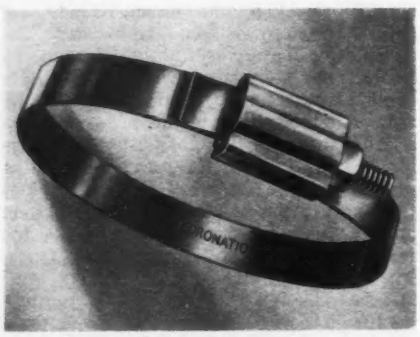


Fig. 31—This hose clip can be made for any diameter hose, using a continuous reel of strip —F. H. Bourner & Co.

threaded through the eye and turned back: since the travel of the eyebolt is limited, this should be done with the strip pulled tight round the hose. Tightening the nut on the eyebolt then secures the clip. Housing and bolt are of alloy steel: hexagon, knurled, or wing nuts can be used: all these parts are zinc plated. Examples of this clip are undergoing trials for A.I.D. approval.

RAILWAY SIGNAL ENGINEERING.—A booklet on railway signal engineering as a career has been published by the British Transport Commission to describe the opportunities which the profession has to offer a young man starting an engineering career in the salaried grades of British Railways. This book is designed to assist in the recruitment of technical staff in connection with the railway modernisation plan and is being issued to universities, schools, technical colleges, and local education authorities.

Digital Computer as an Aid to the Electrical Design Engineer

By B. BIRTWISTLE, B.Sc., A.Inst.P., and BERYL M. DENT, M.Sc.

Abstracts are reproduced here from one of the papers discussed at the Institution of Electrical Engineers convention on digital computer techniques, April 9–13th. This paper examines the digital computer as an aid to the electrical design engineer in the light of the extensive use of the Manchester University computer by the authors during the past three years. Three typical applications of the computer are described: they relate to problems on impulse voltage distribution in transformer windings, supply-frequency ripple on transducer performance, and the starting torque of a synchronous motor. The first and third of these examples are included in the following abstracts.

THE electrical design engineer is often faced with having to solve mathematical problems of a difficult and varied nature. Recently he has tended to make use of analogue computing machines, such as the network analyser[1] the electrolytic tank,[2] the resistance network analogue,[3] the electronic differential analyser,[4] the transformer analogue machine,[5] and a variety of mechanical differential analysers,[6] each type of machine mentioned having some particular application to certain classes of problem. In this country the digital computer has been resorted to by the electrical engineer only on very rare occasions, and mainly for the compilation of some mathematical function or the solution of some extremely complicated equations outside the scope of the analogue machines.

To some extent the difficulty and the time taken in programming a particular problem have, in the past, deterred the electrical design engineer from giving much consideration to the use of a digital computer for his problems. The paper is intended to show, by briefly describing three relatively simple applications, that the digital computer can be a very useful aid to the electrical design engineer.

IMPULSE VOLTAGE DISTRIBUTION IN TRANSFORMER WINDINGS

Statement of the Problem.—To apportion the winding insulation in a transformer the design engineer needs to ascertain the voltage distribution in the winding, which follows the application of a specified impulse voltage. It is well known that the initial surge distribution is determined chiefly by the (interwinding) capacitances, but the subsequent oscillatory state of voltage distribution is much more complicated and has already been the subject of many investigations.[7, 8, 9]

The work described briefly in the paper is a first step towards the development of a method of calculation which would be suitable for use as a routine design procedure. The main requirement of such a method would be the ability to provide results of sufficient accuracy for engineering calculations in a reasonably short time, in order that it could be used as a design method rather than an analytical procedure.

A fuller account, which is in preparation, will include the mathematical formulation of the problem in detail, a full description of the numerical analysis necessary for the solution, and the processes involved in carrying out the problem on the computer, as well as the complete results and an assessment of their value.

The method uses an equivalent circuit in the form of a ladder type network having a finite number of divisions (see Fig. 1). Each division represents one or more winding sections (or occasionally part of a winding section), and any degree of non-uniformity can be present. The effect of mutual inductances between divisions is taken into account. The equivalent circuits represent a transformer winding under the conditions of a normal impulse test, namely, a voltage impulse of known wave shape applied between one end of one phase of a transformer winding and earth, the other end of the winding and all other windings being earthed.

Mathematical Formulation.—The general equivalent circuit for a winding divided into n divisions is shown in Fig. 1.

By formulating the upper and lower mesh equations and eliminating ϕ from them the following simultaneous second order differential equations are obtained for the ϕ variables:

$$p^2\phi_j = Fj\phi_{j-1} + (G_j p^2 + H_j)v(t) \quad . \quad . \quad . \quad (1)$$

where F is an $n \times n$ matrix and G and H are n-element column matrices involving the values of the self and mutual inductances and the capacitances.

The applied voltage $v(t)$ may be a step function, a wave of the form $a(\varepsilon^{-bt} - \varepsilon^{-ct})$ or a chopped wave of the form $a(\varepsilon^{-bt} - \varepsilon^{-ct}) - b(\varepsilon^{-f(t-t_1)} - \varepsilon^{-g(t-t_1)})$.

The voltages to earth at the junction points between the equivalent circuit divisions are given by the following equations:—

$$V_{k-1,\,k} = \frac{1}{C_{G(k-1,\,k)}}(\phi_{k-1} - \phi_k) \quad . \quad . \quad (2)$$

where $V_{k-1,\,k}$ is the voltage to earth at the junction between the divisions $(k-1)$ and (k). The voltage gradients dV across the divisions are given by the first differences of the nodal voltages

$$dV_k = V_{k-1,\,k} - V_{k,\,k+1}. \quad . \quad . \quad . \quad (3)$$

Programme for the Electronic Digital Computer.—The computer used for the calculations required by all three problems described in the paper was the Manchester University electronic computer Mark I. This machine contains an immediate-access cathode-ray tube store of 512 words of twenty digits each and an auxiliary magnetic drum store of 256 tracks containing 32,768 words in all. It is of the type which stores instructions and data interchangeably. Numbers are stored as forty binary digits, giving an

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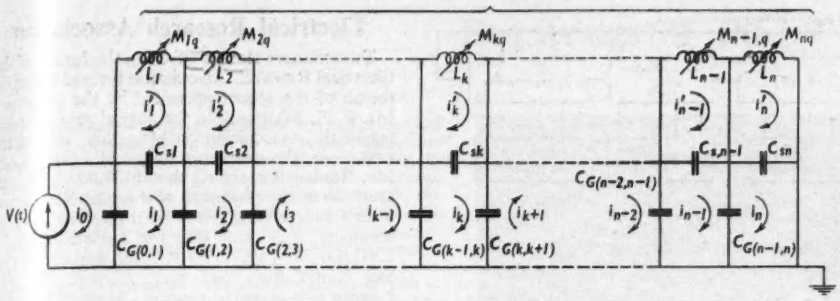
LIST OF PRINCIPAL SYMBOLS

Transformer Problem:

L_k = Self inductance of equivalent circuit division k.
M_{kq} = Mutual inductance between equivalent circuit divisions k and q.
i_k = Lower mesh current in division k.
i'_k = Upper mesh current in division k.
C_{SK} = Equivalent series capacitance for equivalent circuit division k.
$C_{G(k,\,k+1)}$ = Equivalent capacitance to earth between equivalent circuit divisions k and $(k+1)$.
$v(t)$ = Applied voltage wave.
$\phi_k = \int i_k\,dt$.
$p = d/dt$.
$V_{k-1,\,k}$ = Voltage to earth at the junction point between $(k-1)$ and kth equivalent circuit divisions.
dV_k = Voltage gradient across equivalent circuit division k.
a, b, c, d, f, and g = Constants defining the form of the applied voltage wave.
$\psi_k = p\phi_k$.
F, G, H = Matrices defined in the article.
ϕ_a = Instantaneous flux in core A, maxwells.
ϕ_b = Instantaneous flux in core B, maxwells.
N = { Number of turns in control winding of each core. / Number of turns in output winding of each core.
R = { Total resistance of control circuit. / Total resistance of output circuit.
l = Length of mean magnetic path of each core.
V_r = Amplitude of ripple voltage.
V_s = Amplitude of supply voltage.
V_c = Voltage of d.c. source in control circuit.
i_c = Instantaneous current in control circuit, amperes.
i_a = Instantaneous current in output circuit, amperes.
$\omega = 2\pi \times$ supply frequency.
$F(\phi a)$ = Magnetisation curve of core A.
$F(\phi b)$ = Magnetisation curve of core B.
ψ = Flux, maxwells $\times 10^{-4}$.

Starting Torque Problem:

I_{nd} = Direct axis current in the nth damper bar.
I_{nq} = Quadrature axis current in the nth damper bar.
I_{fd} = Direct axis current in field winding.
X = Circuit inductances.
R = Circuit resistances.
$s = 1 -$ (Speed/synchronous speed).
X_d = Direct axis synchronous reactance.
X_q = Quadrature axis synchronous reactance.
r = Stator resistance per phase.
a, b, and c, are defined by equations (11) and (14).
τ = Torque.
I_d = Direct axis currrent in stator winding.
I_q = Quadrature axis current in stator winding.
I_f = Forward component of stator current.
I_b = Backward component of stator current.
I_f = Effective value of i_f.
I_b = Effective value of i_b.



Mutual inductances, M_{pq}, $q=1$ to n, $q \neq k$.

Fig. 1—General equivalent circuit for a transformer winding divided into n divisions

accuracy of twelve decimal digits. For fixed binary point arithmetic the addition time is 1·2 milliseconds and the multiplication time is 2 milliseconds. The time required to transfer the contents of any track to the working store is 40 milliseconds and the reverse operation 90 milliseconds. Input is by five-hole teleprint tape and output is by punched tape or page printer.

Before using such a computer it is necessary to learn how to present calculations to the machine, i.e. how to programme. This involves the translation of computing instructions into the code of the machine and the preparation of punched tape or cards which will insert the instructions and the data into the machine. In the construction of programmes for the Manchester computer the authors were allowed to use the University's library of subroutines, from which the following were taken and incorporated in the three programmes described :—

Input of instructions ; input of numerical data in decimal form ; output of results in decimal digits and tabular form ; division ; exponential ; sine and cosine ; square root ; solution of simultaneous equations ; inversion of matrices ; integration of differential equations by the Runge-Kutta method.

For the transformer problem the programme was designed :

(*a*) To input the given data, namely, self and mutual inductances, series capacitances and capacitances to earth for the equivalent circuit divisions, together with the coefficients of the function $v(t)$.

(*b*) To form the coefficients F, G and H of the n differential equations (1).

(*c*) To integrate the $2n$ first-order equations,

$$p\phi_j = \psi$$
$$p\psi_j = F_{j1}\phi_1 + (G_j p^2 + H_{j1})v(t) \quad . \quad . \quad . \quad (4)$$

The maximum number of equations which could be accommodated simultaneously in the high-speed store during the integration process was forty. The number of divisions in the equivalent circuit was therefore chosen to be twenty, giving twenty second-order and forty first-order differential equations. The programme flow diagram is shown in Fig. 2.

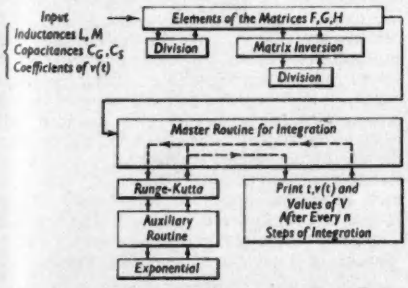


Fig. 2—Transformer problem : programme flow diagram

The effect of changing the number of divisions has not yet been studied. The authors intend to do this and include the results in the fuller account mentioned above.

The following routines were specially designed for this problem :—

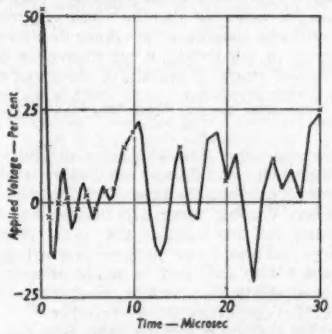
Routines 1, 2, 3 : Form F, G and H.

Master routine for integration : Sets the initial conditions for integration and calls in Runge-Kutta routine and the print routine.

Auxiliary routine : Computes the right-hand side of the forty first-order differential equations.

The time interval for integration is picked up by the machine from the hand switches so that it can easily be changed at any stage. The parameter controlling the number of integration steps before each printing is preset, but it can readily be altered either by using the manual instruction switches or by reading into the machine a short piece of punched-paper tape.

After each printing the variables are written on to the drum, so that if the machine fails at any time a restart can be made from the value of the time variable at the previous printing. The twenty coefficients F, for each equation, together with the corresponding G and H, are written on a single separate track of the magnetic-drum store and are read down to the fast store, when required, by the auxiliary routine.



* Points calculated by Lewis's method.

Fig. 3—Transformer problem : typical intersection-voltage curve (calculated)

An extension to the programme is envisaged which will compute the parameters of the equivalent circuit divisions from those of the individual winding sections.

Results.—So far, results have been obtained for two cases of a uniform winding to which a voltage in the form of a step function is applied. In the first case, the effect of the mutual inductances between division of the equivalent circuit is omitted ; in the second case it is included.

In view of the rapid oscillations in voltage, results were printed for every ¼ microsec for the first few microsecs in each case. For each set of printing the machine performed ten steps of integration. Over the range of 30 microsec the integration steps were 0 (0·025) 10 (0·05) 16 (0·01) 30 microsec. A curve showing intersection voltage against time for a typical section is given in Fig. 3. A direct check on the computer programme was available in the form of a hand calculation made by Lewis's method[10] for a unit function voltage applied to a uniform winding, neglecting mutual inductances. Owing to the laboriousness of the calculation, results were obtained at the following values only of the time :—t (microsec) 0 (1) 10 (5) 50. As shown in Fig. 3, the results obtained by means of the digital computer agreed excellently with these hand-computed values, but show very clearly that, in the latter case, the time intervals were so large that many of the oscillations were completely missed. The maximum errors in the digital computer results compared with the hand calculation, expressed as percentages of the maximum value of the intersection voltage, are as follows :—at 1 microsec, 0·25 per cent ; at 10 microsec, 1 per cent ; at 30 microsec, owing to the large integration intervals, 6½ per cent.

The time taken for the first part of the programme i.e. forming the coefficients F, G, H of the twenty equations, is six minutes, and the time required for one step of integration in the second part is twenty-four seconds. The readings in of the programme tape for both parts and the number tape containing the data occupies ten minutes.

Starting Torque Calculations for Salient-Pole Synchronous Motors

Statement of Problem.—Many synchronous motors are expected to start and pull into step against an appreciable load by running as induction motors, using the damper winding as a squirrel-cage starting winding. Approximate formulæ are available which simplify the calculation of the starting torque and current by reducing the distributed winding to one full-pitched coil in the direct axis and one in the quadrature axis of the machine.

This method gives a close enough answer for normal design work, but fails when unusual spacings of bars, or bars of different materials are used, or when the connections between the damper end plates of each pole are omitted. It cannot predict the currents in the individual damper bars or the dip in the torque/speed curve which may occur at half-speed (George's effect).

These points can only be settled by considering each individual damper bar circuit.

Mathematical Formulation.—An equivalent circuit has been derived[11] which enables the steady-state torques and currents to be evaluated as functions of the machine speed. The principal assumptions made in obtaining the equivalent circuit are as follows :—

(*a*) The mutual and self inductances of the various meshes depend upon the rotor position.

(*b*) The iron behaves linearly.

(*c*) The inertia of the rotor is large.

The evaluation of the steady torque at one machine speed requires the solution of one set of $2(n+1)$ and a second set of $2n$ simultaneous linear equations (where n is the number of damper bars on each axis).

The equations to be solved for the currents in the direct-axis damper-bar circuits, I_{nd}, and the direct-axis field winding currents, I_{fd}, are of the form

$$\begin{aligned} &jsX_0 + (jsX_{00} + R_{00})I_{fd} + jsX_{01}I_{1d} + \ldots \\ &\qquad jsX_{0n}I_{nd} = 0 \\ &jsX_1 + jsX_{01}I_{fd} + (jsX_{11} + R_{11})I_{1d} + \ldots \\ &\qquad (jsX_{1n} + R_{1n})I_{nd} = 0 \\ &\qquad\qquad \ldots\ldots\ldots \quad (9) \end{aligned}$$

where the X's and R's are circuit inductances and resistances and s is the ratio of speed to synchronous speed.

A similar set of $2n$ equations has to be solved to find the quadrature-axis damper-bar currents, I_{nq}.

The direct and quadrature synchronous reactances, X_d and X_q, are then evaluated from the subsidiary equations,

$$X_d(s) = X_d + X_0 I_{fd} + \sum_p X_p I_{pd}$$
$$X_q(s) = X_q + \sum_p X_p I_{pq} \quad . \quad . \quad . \quad (10)$$

The following quantities can then be evaluated :

$$a = -r + (1-2s)_j X_q$$
$$b = -r + (1-2s)_j X_d$$
$$\ldots\ldots \quad (11)$$

where r is the stator resistance per phase.

The required steady state torque is then given by the expression

$$\tau = \tfrac{1}{2}\left[i_d \,.\, (X_q i_q) - i_q \,.\, (X_d i_d)\frac{1}{c^2} \right] \quad . \quad . \quad (12)$$

where the dot signifies a scalar product and

$$i_d = ja/c \; ; \; i_q = b/c \quad . \quad . \quad . \quad (13)$$

and

$$c = (1-2s)X_d X_q + r^2 + jrs(X_d + X_q) \quad . \quad (14)$$

Other quantities of interest are

$$I_f = \tfrac{1}{2}|\, i_f \,| \quad \text{where } i_f = (1/\sqrt{2})(i_d + ji_q), \text{ and}$$

$$I_b = \tfrac{1}{2}|\, i_b \,| \quad \text{where } i_b = (1/\sqrt{2})(i_d - ji_q).$$

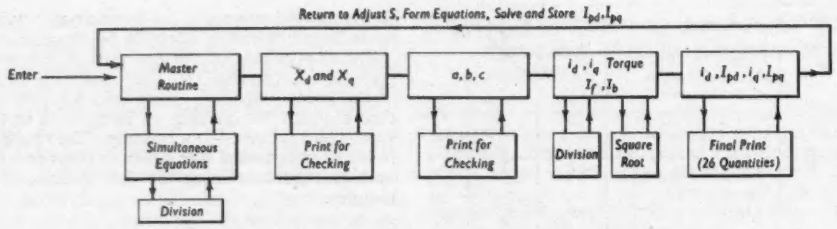


Fig. 4—Starting torque problem : programme flow diagram

Programme for the Electronic Digital Computer.—The programme flow diagram is shown in Fig. 4.

The following routines were specially written for this problem :—

Master Routine.—It modifies equations by multiplying appropriate elements by s, it calls in the simultaneous equation routine to solve equations and stores the values of I_{pd}, I_{pq}.

Routine 1.—It forms X_d and X_q.

Routine 2.—It forms a, b, and c.

Routine 3.—It forms i_d, i_q, r, I_f and I_b.

Routine 4.—It forms auxiliary quantities i_d, I_{pd}, i_q, I_{pq}, and prints out all quantities required.

The intermediate print routines indicated in Fig. 4 are only used for checking purposes and are suppressed when a "production" run is carried out. As the programme stands at present the equations arising from motors with up to fourteen damper bars can be solved.

Results.—Fig. 5 shows a typical torque/speed

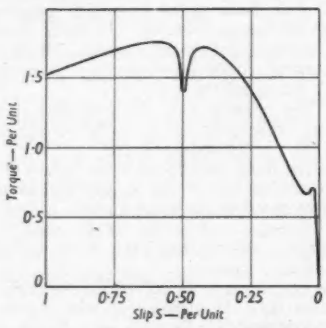


Fig. 5—Starting torque problem : torque/speed curve for motor with four damper bars

curve obtained for a motor with four damper bars. Values of the slip s were taken from 1·0 to 0 at intervals of 0·05. Finer intervals of s were used around $s \simeq 0{\cdot}05$ and $s \simeq 0{\cdot}5$, where it was expected that minima in the curve would arise. In this case also the required accuracy in the results was limited by the accuracy of the data to three significant figures, and the computer was more than adequate for the demand.

For this problem ten simultaneous equations had to be solved for I_{pd} and eight equations for I_{pq}. After each value of s twenty-six quantities were printed out, which took fifty seconds, the corresponding computing time being forty seconds. Thus a complete torque/speed curve, together with a large table of auxiliary quantities, was obtained in about twenty minutes.

General Conclusions

In each electrical design problem described, a method of solution using a high-speed digital computer has been given. In each problem the use of alternative methods involving analogue computers would be somewhat difficult or inconvenient. Furthermore, all programmes developed could be adapted without difficulty for the solution of analogous problems For example, the calculation of damping torques, short-circuit and single-phase operations could be performed by means of variations of the starting torque programme. Other calculations, requested by electrical design engineers and carried out by means of such a computer, include the evaluation of functions and the preparation of tables with many combinations of values of the parameters and variables.

The advantages of the high-speed computer compared with previously existing numerical methods are fourfold :—

(i) The speed of an individual calculation is enormously increased—factors of several hundred times being quite common. While the programming time may be considerable, it should be remembered that, once a programme has been developed and tested, subsequent computations requiring the same arithmetical processes but different numerical values of the data require only the preparation of a new number tape, which takes about the same time as would be taken in typing out the data.

(ii) It is possible to undertake much larger computations than could otherwise be contemplated, e.g. calculations involving the inversion of large matrices or the solution of a large number of simultaneous differential equations.

(iii) In the time normally available for design work it enables many more designs to be tested for required characteristics, and this gives the design engineer scope for experiment.

(iv) Because the electronic digital computer can be programmed to perform not only arithmetical processes but also the whole organisation of a problem, including the choice of alternative sequences of calculation, it can relieve the design engineer of much, if not all, of that part of his work which involves no experience or judgment, and can thus release him for more creative effort.

At the present time the main difficulty preventing wider use of these computers is that of programming, but as time goes on and programmers become more experienced and more programmers are trained, the time taken to develop and check new programmes will greatly decrease. Use will also be made of automatic coding methods, such as that developed at Manchester University by R. A. Brooker.[12]

To the authors it appears clear that the high-speed digital computer can provide considerable assistance to the electrical design engineer and certainly warrants further attention. A probable development of great interest and one which is well within the potential of this type of machine is that of carrying out automatically the optimum design of many products, using the basic data supplied by the engineer.

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[10] Lewis, T. J.: "The Transient Behaviour of Ladder Networks of the Type Representing Transformer and Machine Windings," *Proc. I.E.E.*, Paper No. 1691S, October, 1954 (101, Part II, page 541).

[11] Rankin, A. W.: "Asynchronous and Single-Phase Operation of Synchronous Machines," *ibid.*, 1946, 65, page 1092.

[12] Brooker, R. A.: "An Attempt to Simplify Coding for the Manchester Electronic Computer," *British Journal of Applied Physics*, 1955, 6, page 307.

Industrial Safety Training Centre.—The Birmingham and District Industrial Safety Group has opened a training centre at Summer Road, Acocks Green, Birmingham, 12. This centre is equipped with modern plant for instructional purposes and has a lecture hall with facilities for showing films on safety and allied subjects. A series of courses covering the main safety aspects in many branches of industry has been arranged, and particulars of these courses can be obtained on application to the centre.

Electrical Research Association

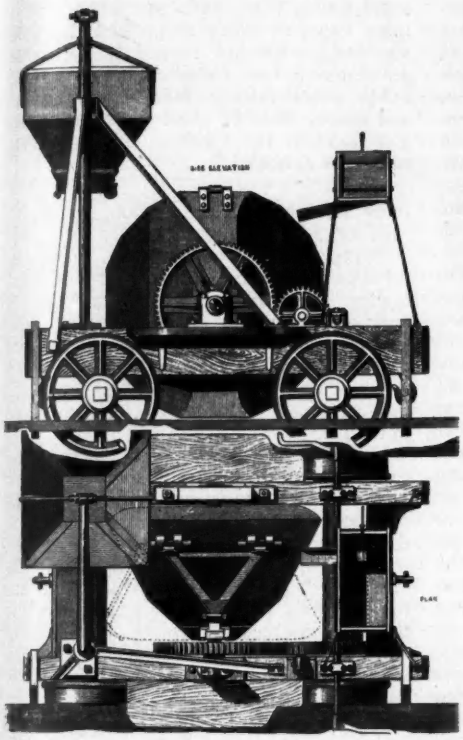
Two matters closely affecting the future of the Electrical Research Association formed the main theme of the report presented by the chairman, Mr. F. H. Bramwell, to the annual general meeting of the Association on May 2nd. About the first topic, the new laboratories at Leatherhead, Mr. Bramwell reported that £100,000 had been spent from the resources of the Association and a little over £200,000 had been received from its members, thus qualifying for a contribution of £200,000 from the D.S.I.R.; the greater part of this contribution had been received and the balance was expected shortly. Most of the staff and equipment would be moved from Perivale to the Leatherhead laboratories by the end of June. There had been unavoidable delays in building work (the completion date in the main contract was December 31, 1955). However, the Association was satisfied that, with the possible exception of the main hall section of the high-voltage building, this building and the main block would be ready for occupation before the end of June. On the second topic, that of finance, Mr. Bramwell said that near the end of the quinquennial period of grant from the D.S.I.R., the E.R.A. had a total income from all sources of about £340,000 per annum, of which just over a half was grant-earning and qualified for the maximum annual grant of £100,000 from the D.S.I.R. The terms on which the D.S.I.R. would be prepared to make grants to the E.R.A. for the next period would not be known until the E.R.A. application had been considered later in the year. Nevertheless, it had been intimated unofficially that, certainly by the end of the next quinquennial period, the E.R.A. would "be required to increase its grant-earning income very materially to qualify for anything like the maximum grant that it has been receiving of £100,000." By comparison with other research associations the ratio of grant-earning income to grant of 1·7 to 1 was very low. Mr. Bramwell went on to say :

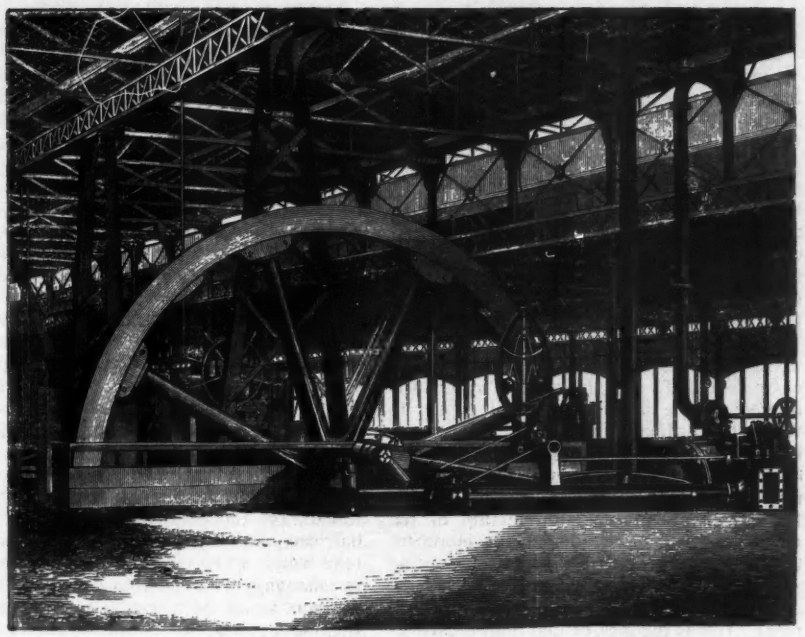
"To have any hope of being granted £100,000 per annum by the D.S.I.R. it would appear that the Association will be expected to have a grant-earning income of at least £300,000 per annum by the end of the coming quinquennial period ; that is, an increase in the grant-earning income of over 75 per cent in the next five or six years. This means a large increase in the contributions from all our voluntary supporters, the C.E.A., the Area Boards, and the electrical manufacturing firms ; but I think it may be taken as indicating the feeling in the Government and in the D.S.I.R. particularly, that the support being given by the electrical industry generally to this co-operative research effort, is not really adequate and commensurate with the size and importance of the industry ; nor sufficient to enable the Association to make the fullest use of its unequalled facilities. In this connection the subscriptions from the electrical manufacturers amount only to a very small fraction of their total expenditure on research, and to provide the Association with what is necessary over the next five to six years would only make a very small percentage increase in their total research expenditure. There are many problems to be solved that are common to a number of manufacturers, and from the national point of view of economy of resources, not only financial, but, what at the present time is far more important, the use of the limited number of scientists and technologists, it is surely the right policy that such problems should be investigated at one central co-operative establishment rather than be duplicated in the research departments, however efficient, of a number of manufacturing firms."

Silver-Faced Contact Rivets.—A new silver-faced composite rivet contact developed by Johnson, Matthey and Co., Ltd., 73–83, Hatton Garden, London, E.C.1, has a tubular copper shank to simplify riveting. This design of rivet is stated to be highly efficient electrically and thermally, while the thickness of the silver face—a minimum of one-third of the total head thickness—ensures long life. The rivets are given a light silver electro-deposit so that good contact can be made with the contact member on assembly. The contacts are made in four standard head sizes, from $\frac{1}{16}$in to $\frac{1}{4}$in diameter, with both domed and flat faces, and three shank lengths of 0·035in, 0·060in and 0·090in.

Engravings of 1867

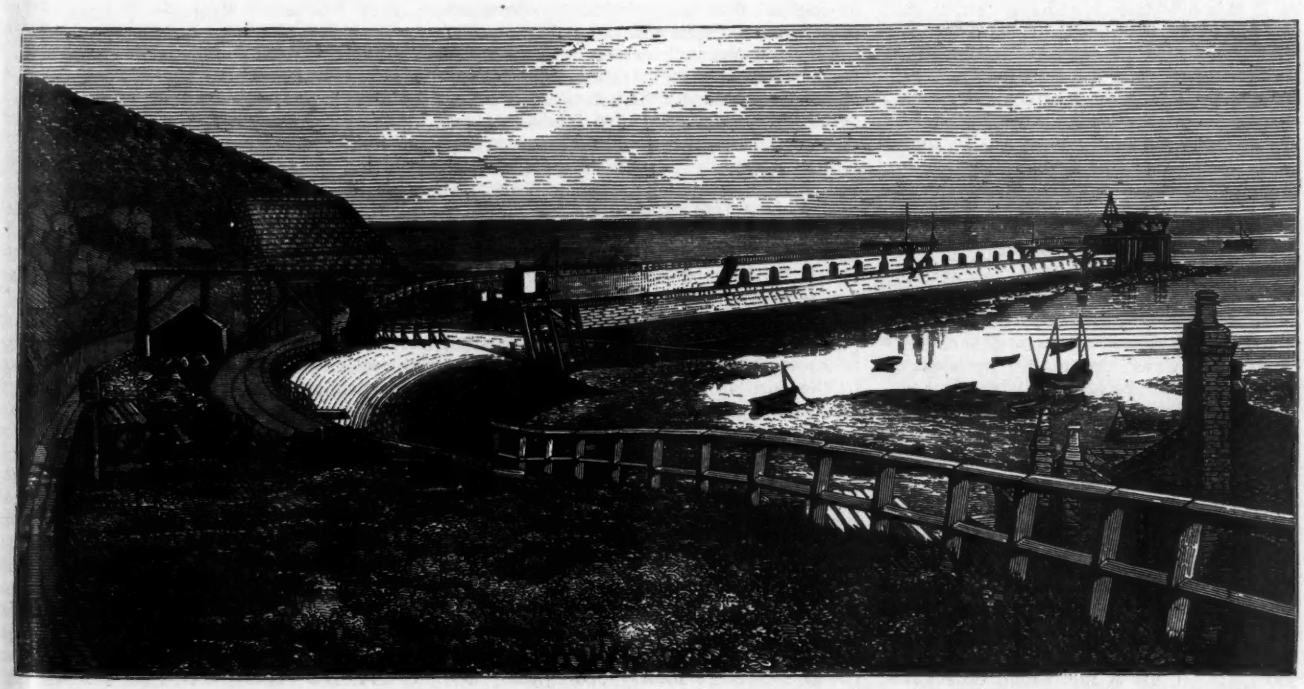
The concrete mixer, which is illustrated below, was designed by Mr. P. J. Messant, M.I.C.E., for use in the construction of the Tyne piers. It was described in our issue of May 10, 1867, where it is stated that "when the mixing is completed, the mixer is stopped with door and opening downwards, the fastening of the door is released and the charge of concrete falls in a mass into its place, the discharge being instantaneous. The opening is then turned upwards. The hopper suspended by the davit is brought over the opening and discharged into the mixer in a few seconds. The proper quantity of lime or cement brought from the store in a bag is at the same time put into the mixer and the water from the cistern. The door is then closed and made tight by a blow from a hammer, on the head of the double wedge fastener. The mixing, by turning the mixer, and the filling of the hopper and water cistern, are again resumed."





In our issue of February 1, 1867, we began a profusely illustrated description of the Schneider works at Le Creusot. The engraving above, which has been reproduced from that description, illustrates the forge and shows the "60-ton flywheel of the plate rolls." Our article says: "proceeding down the forge the visitor finds the general and larger merchant iron, angles, etc., next the rails, and then two great trains, one for the largest size of bars, the other for armour plates. These, with their engines of 600 horse-power, are not yet complete, but close to them are the largest plate rolls now in use, which are a very fine train, and have sixty-ton flywheels. The medium and lighter plate rolls come next, and there is still space in the building for more machinery, which will be required when the full number of 126 puddling furnaces is completed."

In our issue of March 22, 1867, a description of the Tynemouth Harbour improvement works may be found. The engraving below shows the "north pier from the inner side." The description explains that the "inner or southern half of the pier, at the level of 10ft above high-water line, is paved to form a quay, while the northern half is raised so as to form at the height of 20ft above high-water spring tide line, a paved promenade, 13ft wide, protected by a stone parapet 4ft higher, which gives 24ft as the height of the parapet above high water, and 39ft above low-water spring tide . . . The portion of the pier walls below low water consist of large blocks of masonry and concrete, the facing being exclusively of the former, weighing from six to fifteen tons, built on shore and afterwards placed in their permanent position by divers."



LITERATURE

Diesel Operation and Fault Diagnosis. By GERALD B. FOX. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 21s.

By commemorating in the first paragraphs of his book the work of Akroyd Stuart, Mr. Fox reminds us of the debt due to this pioneer of the petroleum engine. The time must certainly come when the debt will be better recognised, since by describing all compression-ignition oil engines as "diesel" engines, a gross injustice is done not only to Akroyd Stuart, but to other men whose labours contributed to the development of this class of prime mover. The late Professor Robinson expressed very fairly the grounds upon which the priority of the Akroyd Stuart engine is based. It is, he writes, "of historic interest as the first practical oil engine in which the ordinary methods of ignition by heated tube, flame or electric spark, are dispensed with, and the charge of oil, injected into compressed air in a red-hot chamber, is fired automatically by compression of the motor piston." The amazing development of the compression-ignition engine during recent years has followed in great part the evolution of suitable fuel-injection equipment. It was the lack of fuel pumps capable of remaining serviceable for long periods with high delivery pressures which postponed the general abandonment of blast-air injection, though, as pointed out by Mr. Fox, many blast-injection engines are still in operation for electric generating and pumping service as well as for marine service. It could also be stated that some of these engines have established an altogether exceptional record in respect both of long life and freedom from serious breakdown. We recall a remark made many years ago by the late Charles Day to the effect that had the direct-injection method been persisted in from the outset, the appearance of the blast-air injection system might have been hailed as heaven-sent by engine manufacturers struggling to arrive at satisfactory combustion with unsatisfactory fuel-injection pumps. Whatever truth there may be in this reflection, it remains certain that the fuel-injection equipment is indeed the vital element in the modern compression-ignition engine, and we note that Mr. Fox deals with it in his second chapter. This chapter is of strong practical interest and among other valuable advice will be found some worth-while recommendations relating to high-pressure fuel-injection pipes.

Mr. Fox possesses the valuable faculty of expressing himself without ambiguity when dealing with technical matters such as those dealt with in the present book. An example is found in the following extract from his admirable chapter on fuels: "Class A fuel is known as a gas oil and class B is called a diesel fuel. Careful note must be taken of the nomenclature because the term 'fuel oil' implies a boiler fuel, not belonging to class A nor to class B. Fuel oil has a higher specific gravity than either of the foregoing classes and is higher in sulphur and coking value. In fact, it is quite unsuitable for use in the small high-speed engine and is only usable in the medium-speed large engine after special treatment and under supervision. In very general terms diesel engines might be divided into three groups: (1) small, 1200 r.p.m. upwards; (2) medium size, 500 to 1200 r.p.m.; (3) large, below 500 r.p.m. Class A fuel would be suitable for all groups, class B for the second and third groups, and boiler fuel (after treatment) for the third group only."

This is plain English and Mr. Fox follows it up by stating the grounds, in experience, on which his advice is based. Anyone reading the sentences quoted above will wish to study the whole of the chapter from which they are taken, particularly as the subject is expounded by a prominent researcher, who, himself a mechanical engineer of great experience, is writing for the guidance of those responsible for engine operation and maintenance.

On the subject of lubrication—the importance of which can hardly be over-stressed in a treatise of this kind—Mr. Fox has this to say on the controversial topic of detergent oils: "Concerning whether or not to use an H.D. oil must depend upon the conditions and be decided by the user, bearing in mind that certain additives, known as detergents, will definitely raise the ring-sticking temperature of the top piston ring. Thus, if there had been a tendency to stick at or near full load when using the straight mineral oil, by changing to a suitable detergent (H.D.) oil there would be a complete freedom from sticking at that load. It would, in fact, permit the engine to be run at some 10 per cent higher brake-mean-effective-pressure before sticking of the rings took place. In terms of piston temperature it would amount to 20 deg. to 25 deg. Cent. On the other hand, if the engine be moderately rated and has run for long periods with neither ring sticking nor an excessive wear of rings or liner, then there would not be any point in changing to an H.D. oil." It is to be noted that Mr. Fox emphasises the rating of the engine and he would doubtless agree that among other factors influential in respect of ring sticking and liner wear are the general design of the engine and the provision made in respect of piston cooling. We must not forget that the description "diesel" engine is applied indiscriminately to a high-speed bus engine with trunk pistons and to a slow-speed marine engine of crosshead type with oil-cooled pistons, oil-cooled crosshead guides and complete separation between the combustion chamber and the crankcase. A point in respect of the filtration of lubricating oil which we do not find mentioned is the desirability of passing the lubricating oil through a magnetic strainer. This is a procedure frequently adopted on engine test beds and there are many engine users who regard the fitting of magnetic oil strainers as a desirable precaution on the fuel oil circuit as well as on the lubricating oil circuit. It is the particles of around 6 micron size which appear to be most damaging to fuel injection pumps. On the subject of piston rings, it would have been interesting to know what Mr. Fox has found in regard to the wearing qualities of cast iron rings machined from (1) centrifugal castings, and (2) sand castings. Piston pins are dealt with in some interesting pages, certain of the contents of which recall experiments made in 1913 by the late George Windeler. At that time (1912–1913) considerable piston pin bearing trouble was experienced on more or less all makes of compression-ignition engines. Windeler found that one cause of the trouble arose from gradual loosening of the piston pins in the eyes of the piston and deductions made from his investigations (which included statically loading the piston pin) led to a general amelioration of the trouble and ultimately to the stepped connecting-rod top-end bearing which at a considerably later date became widely used on Mirrlees and other engines. The attentive reader of this book will recognise, from the outset, that it is the work of a man who has devoted himself to finding out why things go wrong. Mr. Fox would agree entirely with certain wise advice tendered as long ago as March, 1786, in a letter addressed to Matthew Boulton by James Watt: "Above all, patience must be exercised and things cooly examined and put to rights, and care be taken not to blame innocent parts. Everything must, as much as possible, be tried separately. Remind those who begin to growl, that in new, complicated, and difficult things, human foresight falls short—that time and money must be given to perfect things and find out their defects, otherwise they cannot be remedied."

Fluid Mechanics. Third edition. By R. C. BINDER. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 45s.

"FLUID mechanics is that study of fluid motion involving a rational method of approach based on general physical laws and consistent with the results of modern experimental study. The word fluid implies a treatment of both liquids and gases. Fluid mechanics uses the same principles employed in the mechanics of solids."

Dr. Binder, Professor of Mechanical Engineering at Purdue University, in the United States, starts his preface with the sentences quoted above, and continues in the same direct manner and, in places, unattractive style, throughout his book. His aim is to "present an introduction to the fundamentals of fluid mechanics," and in this he undoubtedly succeeds. Designed for students of fluid mechanics and hydraulics, with a bias towards mechanical engineering, the book will be of assistance to its readers, both by its emphasis on fundamental physics and as a source of information on certain practical applications.

Part I—"Basic Relations"—consists of seven chapters which occupy a little over one-third of the book and contain the material which would be expected to be covered in just over one term of study in an honours course. Part II—"Applications in Fluid Mechanics"—contains altogether fourteen chapters, the first six of which deal with the flow of incompressible fluids in pipes, fluid meters, flow in a curved path, resistance of immersed bodies (i.e. form drag), dynamic lift, and propulsion and craft motion; two important chapters deal with fluid machines (pumps, fluid motors, turbines, fluid couplings and torque converters); too brief a chapter covers open channels, and this is followed by two interesting chapters on compressible flow and one on fluid power and control systems. Two more excellent chapters on lubrication and on unsteady flow and noise, together with a list of answers to the large number of numerical problems which should provide a useful stimulus to the student, and a brief index, complete the book.

From this list it will be seen that the arrangement of subjects is logical, and each chapter is equally logically subdivided and methodically treated. It should, however, be appreciated that far from the whole syllabus of an honours course is covered, and that the mathematical equipment expected of the

student is not up to university standard. The conscientious student who consults the well-chosen selected references quoted at the end of each chapter will, therefore, notice a large gap between this treatment and the more advanced and rigorously complete ones to be found elsewhere. On the other hand, Professor Binder is clearly an excellent teacher, and his book will be of particular value to the man who cannot easily understand problems he may have encountered in his lectures or in practice, particularly if the difficulty arises out of the connection with fundamentals. The production of the book and the numerous illustrations are splendid.

Two general thoughts are provoked by the study of this work. The first, not confined to fluid mechanics, relates to the need for engineers to have a broad education and not to see each applied science in isolation. The idea that engineers should have courses of lectures in subjects commonly called "the humanities" appears, by the very isolation of their treatment, to defeat that object; the best way of ensuring the broadening of outlook required seems to be to emphasise the connection with other fields at all possible points. Another aspect of the same problem is one this journal has much at heart: science and engineering can perhaps be seen more clearly in relation to other fields of human activity if their development is traced and their history invoked. Professor Binder would further enhance the value of his book if, in the next edition, he could stress the links with other sciences, provided—for example—by applied mathematics, and if more attention were paid to history. He is quite correct, of course, in his treatment of the general energy equation (with the use of "enthalpy," which will be unfamiliar to some readers, but provides a useful link with thermodynamics), and in his derivation of the Bernoulli theorem; but which of his readers would know that there were three brilliant men of that name, and that all of them made contributions to the science, or when they flourished?

Lastly, the matter of language with which we started. It is now accepted that the various branches of the English-speaking family use their own spelling, but the practice has grown up in this country of submitting manuscripts to be published on both sides of the Atlantic to special scrutiny so that a book can be read by all with ease and pleasure. Would such a procedure closely check Professor Binder's idea—or, as we should put it, would the Professor agree with it?

Metallurgy of the Rarer Metals: No. 4, Titanium. By A. D. McQuillan and M. K. McQuillan. Butterworth's Scientific Publications, 88, Kingsway, London, W.C.2. Price 56s.

The series of books dealing with the metallurgy of the rarer metals has received an important addition in the publication of this volume on titanium. Titanium has attracted far more attention in the popular press than any of the metals previously dealt with in the series, and has been hailed as a "wonder metal" in much the same way as aluminium was about a hundred years ago. The development of the industrial technology of the metal has been extremely rapid, and many papers and articles on titanium and its alloys have appeared in scientific and technical journals during the last few years. Among these are the considerable contributions to the study of the constitution and properties of titanium alloys made by the two authors. The publication of this authoritative account of the basic principles of the production of titanium, with a critical assessment of the physical and mechanical properties of the metal and its alloys, is, therefore, most opportune. The scattered references are assembled in their correct perspective and presented as a unified picture of the subject.

The fourteen chapters of the book cover the history and occurrence of titanium, its recovery from its ores, purification, melting and casting, fabrication and joining, the physical and mechanical properties of the metal, its reaction with gases and corrosion behaviour in various media: and similar information is given about the titanium-rich alloys, their constitution, heat-treatment and properties.

In America, commercial production is almost entirely by the Kroll process, consisting of the reduction of titanium tetrachloride by magnesium. Other reducing agents have been used, and in the only plant in operation in Great Britain the reduction is effected by sodium. The book contains no further description of this plant or process. The method by which the purest metal is obtained (thermal dissociation of titanium iodide vapour with deposition of the metal on a hot filament) has only a very limited commercial application at present on account of its high cost and other difficulties; though it may possibly be found in the future that the use of very high purity titanium may result in improved alloys.

The problems associated with the melting and casting of titanium, arising from its high melting point and the extreme reactivity of the molten metal with refractory materials, are very great and are described in detail; but the manufacture of fabricated parts, from the large ingots of titanium and titanium alloys now being produced by arc melting in an inert atmosphere, has not been found to present so many difficulties as was at first feared. Accordingly, commercial technique for the fabrication of titanium and its alloys is developing very rapidly. The principles involved in various processes of working titanium are described.

Rather more than two-thirds of the book are concerned with the properties of titanium and its alloys. As is well-known, the combination of low density with high strength and remarkably good resistance to corrosion makes titanium attractive as aircraft constructional material. The resistance of titanium to corrosion is outstanding. Commercial titanium has been found to be completely unaffected by five years' exposure to the atmosphere in industrial, rural and marine environments. It remained unaltered after long immersion in sea water and resisted cavitation erosion and corrosion fatigue, suggesting that applications may be found in marine engineering and ship construction. On the other hand, the high-temperature properties of titanium are apparently not so good as it was at one time expected they would be, though some commercial alloys (e.g. the alpha-solid-solution titanium-tin-aluminium alloys) show an improvement over the pure metal in this respect.

Applications of titanium are wisely not discussed in this book. The properties recorded are allowed to speak for themselves. By virtue of these properties many possible uses suggest themselves, but every new application will demand some economic justification. If the cost of titanium falls appreciably its field of application will be correspondingly widened; and progress in the commercial production of the metal has been so rapid that some considerable fall in cost may be expected before many years are past. Meanwhile, this book indicates the probable course of future developments in the technology of titanium and its alloys, and supplies the data on which a sound judgment of potential applications of these new materials may be based.

Fifth Symposium (International) on Combustion. Chapman and Hall, 37, Essex Street, London, W.C.2. Price 120s.

The 1954 symposium of The Combustion Institute was devoted to "Combustion in Engines and Combustion Kinetics." Forty-five papers, one-half of those contributed, covered the latter subject, whose importance is made clear to the engineer in the invited review papers that occupy the first 100 pages of this volume. These deal, first, with piston engines, looking to fundamental research for increased efficiency from the knock-limited petrol engine and for operational advantages, particularly reduced visual, aural and olfactory annoyance, from the diesel; however, the empirical success of the M.A.N. "whisper motor" is praised. The problems of liquid and solid-fuel rockets, turbo- and ram-jets are dealt with separately, the papers portraying in a valuable manner the state of the art in each field. The problems in each case include stability, but it is in the monopropellant motor that studies on the molecular scale are most prominent. Surveys of combustion kinetics commence with gas phase reactions, discussing how far systems with non-equilibrium energy distributions may be characterised by a "temperature," and proceed to the collision processes in hydrocarbon combustion, where the internal configuration of the molecule may change to render any collision diameter invalid; a more detailed study of the combustion of simpler paraffins then appears. The penultimate review paper examines the ultimate limitations imposed by the kinetics of combustion upon space heating rates, showing that existing combustion systems appear to be limited in their output by the time required for mixing air and fuel. A study of flame velocities and the turbulence behind a grid is then used to make a theoretical determination of space heating rates in a closed duct, stability being assumed to exist. The original papers presented to the symposium cover the combustion of fuel droplets, combustion of solids, propellant burning, special research techniques, diffusion flames and carbon formation, flame spectra and dissociation energies, and combustion phenomena, such as cool flames, in engines. The proceedings of two brief panel discussions are included in the volume.

Books Received

Heat Engines. Fourth edition. By A. C. Walshaw. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 16s.

Technology of Heat. By H. Wright Baker. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 36s.

Simple Perspective Drawing. By Arthur R. Brown. Crosby Lockwood and Son, Ltd., 26, Old Brompton Road, London, S.W.7. Price 6s.

Applied Electricity. Third edition. By A. W. Hirst. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 25s.

Methods in Numerical Analysis. By K. L. Neilsen. The Macmillan Company, 10, South Audley Street, London, W.1. Price 48s. 6d.

The Constitutional Diagrams of Alloys. Second edition. Compiled by A. Prince. The Institute of Metals, 4, Grosvenor Gardens, London, S.W.1. Price 35s.

The New American Machinist's Handbook. By Rupert LeGrand. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 67s. 6d.

The Geneva Motor Show

No. II—(*Concluded from page* 416, *April* 27*th*)

WESTERN Germany, after the almost complete destruction of her motor industry in the last war, did not start deliveries to Switzerland until the middle of 1948. Having regained the greater part of her industrial potential by the end of 1950 she gradually increased her export drive and has shown enterprise and vigour not only in recovering her former markets, but in opening up new ones, thus constituting a danger to British export markets. Germany, at present, is probably the greatest motor exporter of the world; her exports to Switzerland in 1955 amounted to about 54 per cent of the total Swiss imports, and were mainly due to the sales of four makes, namely, Volkswagen (V.W.), Opel, Ford and Mercedes, which met about 46 per cent of the Swiss demand.

By far the greatest part of the German export consisted of V.W. cars, every fifth car registered in Switzerland in 1954 and 1955 being a Volkswagen. A great deal has been written about the success of this car, which, designed before the war, is being built without any major alteration at the present rate of about 1400 per day, and has made a sensational advance in world markets. It is futile, in our opinion, to discuss whether the still increasing sales of this unconventional air-cooled rear-engined car are due to its design and performance or to the promotion and marketing technique of its manufacturers. The fact remains that the great majority of about 50,000 Swiss V.W. owners seem to be satisfied with the economy, the road-holding, and the general performance of the car under extreme climatic conditions. The manufacturers have also succeeded in building up an organisation, offering cheap and easily available after-sales service and fixed-price maintenance, thereby establishing a dealer-to-customer relationship equal to the best American standards. Further, cleverly conducted propaganda has greatly assisted in eliminating any inferiority complex the owner of a small, inexpensive and not particularly stylish car might feel, by stressing such points as unfailing reliability, longevity and so on, in short by emphasising the V.W. as a highly efficient and economical means of transport. By these and other means the Volkswagen has gained a reputation which, for the time being, should make it almost immune from any serious competition in its own particular category.

The German car next in popularity to the Volkswagen is the Opel "Rekord," a two-door four-seater of orthodox design. This car, fitted with a 1·5-litre four-cylinder engine, has the favourable power-to-weight ratio of 55 h.p. per ton, and though slightly more expensive than the V.W., is popular with customers who prefer the lower noise of a water-cooled engine, the better appearance and the larger luggage boot. The "Rekord" and its bigger companion, the 2·5-litre six-cylinder "Kapitän," a roomy but light six-seater of the semi-luxury class, shown in Fig. 5, are being made by the Opel Works, a subsidiary company of the General Motors Corporation. They are distributed by the Swiss General Motors Company and enjoy the benefits of the efficient sales networks built up by the parent company at an earlier period when America dominated world markets.

The third on the list of popular German cars is the Ford "Taunus," built by the American controlled Ford Company of Cologne. Like the Opel, it is distributed by its parent company. The 1·2-litre "Taunus M.12," similar in appearance to, but slightly bigger than, the "Anglia," was first marketed in 1952 and for many years had the reputation of being one of the best-looking modern small cars. The export sales of the "Taunus," not only in Switzerland but also in other Continental markets, have greatly increased since the introduction, early last year, of the improved "Taunus M.15," a car basically identical with the model "M.12," but fitted with a modern o.h.v. short-stroke engine instead of the former 1·2-litre side-valve engine. The designers have wisely refrained from increasing to any great extent the maximum speed of the "M.15," the high output of 55 h.p. and the greatly increased maximum torque of about 82ft-lb at 2000 r.p.m. of the new engine being mainly utilised for improving the flexibility and general performance of the car. Contrary to American practice, the "Taunus M.15" is optionally available with a four-speed gearbox, which makes it particularly suitable for operational conditions in Switzerland.

Fig. 6—A 2553 c.c. engine developing 83 h.p. at 4200 r.p.m. powers the new "Zephyr"

The reputation of Mercedes (Fig. 7) which, before the war, commanded a considerable market in Switzerland, remains unchallenged. The impressive success in international motor racing of this old established firm has proved an important factor in promoting new sales in the more expensive class of cars. The centre of attraction on the Mercedes stand was the type 190 SL, a sports car fitted with a 1·9-litre four-cylinder overhead camshaft engine, developing 105 h.p. at 5700 r.p.m. Unlike the well-known models 180 and 220, the type 190 SL is characterised by a modern body style.

Among other German cars selling at the rate of more than 1000 annually are the 900 cc two-stroke front-wheel drive D.K.W. and the Borgward "Isabella." The latter, a 1·5-litre car with independent all-wheel suspension, has been able to increase its sales in Switzerland from 213 units in 1954 to 1073 last year, a success almost entirely due to its appearance, which seemed to appeal particularly to the feminine taste.

Fig. 5—The 2·5 litre Opel "Kapitan"

British Exhibits

Out of eighty-two makes of cars, exhibited at the Geneva show, twenty-nine were British—the biggest contingent of all. This impressive

number indicates that the British motor industry is fully aware of the importance of the Swiss market and, generally speaking, of the necessity to increase its export drive on the Continent. Great Britain had her best year in 1947 when she sold 8257 cars to Switzerland, supplying about 30 per cent of the annual Swiss demand. With the re-appearance of Continental competition, the relative proportion of British sales gradually dropped to about 11 per cent in 1953, and has remained practically constant at this figure during the last two years. Table I *ante* shows that the absolute import figures in 1955 rose by 1300 units compared to those of 1954 (mainly at the expense of American sales), an increase which is practically proportional to the general expansion of the Swiss market. The main contribution to the increased sales of British cars must be attributed to the efforts of the Ford Motor Company, which, last year, imported about 1100 cars more than in 1954, thereby improving its position on the list of Swiss motor imports from eighth to fifth (Table III *ante*). The next British manufacturers on this list, which contains all makes selling more than 500 cars per year, are Vauxhall in fifteenth place and Austin in seventeenth place. Table IV shows that only four other British makers, namely Morris, Land-Rover, Hillman and M.G., sold more than 100 cars per year, while sixteen other firms had to be content with annual sales not exceeding fifty.

This survey of statistics clearly emphasises the main weakness of the British motor industry, namely that too many individual firms, making far too many different models, largely overlapping one another in price, appearance and performance, are competing on a restricted market. The multiplicity of types is a definite handicap, making it very difficult to build up an efficient sales and service organisation, as few dealers are prepared to maintain more than an essential stock of spare parts.

Ford and Vauxhall (represented by their American parent companies), which, by the way, account for about 75 per cent of all British exports to the European Continent, head the list of British importers to Switzerland, their combined sales exceeding the sales of all other British firms by about 50 per cent. It must be mentioned, however, that G.M. and the Ford Motor Company, which also distribute the products of their German subsidiary companies, seem to find less sales resistance in selling the German makes than the British ones. The Swiss Ford Company, for instance, last year sold 10 per cent more units of the "Taunus" than of four British models, and the General Motors Corporation sold eight and a half times as many Opels as Vauxhalls. This rather striking discrepancy is partly due to the fact that many accessories and components, especially in the electric equipment, are to a great extent standardised on the Continent, so that spare parts and service facilities are available almost everywhere. To a greater extent, however, the popularity of the German built Ford and Opel can be attributed to one fundamental weakness, common to all the medium-sized cars produced by the American inspired British firms. We refer to the practice employed by Ford and Vauxhall of providing two models of widely different performance and, incidentally, catering for two different classes of users, by making a body shell to accommodate either a four-cylinder engine or a six-cylinder engine of a 50 per cent higher output. This method, though quite effective in keeping the cost of production low, compels the designer either to compromise between two different classes of car or to emphasise one type to the disadvantage of the other. As a result of this practice we are liable to build cars which are either "over-bodied," with a power-to-weight ratio below the Continental standard of about 45 h.p. per ton, or cars having ample engine power, but not the handling and riding properties of really well proportioned vehicles designed in complete harmony with their engines.

The new Ford cars which a few weeks ago were introduced in London, and then made their first public appearance abroad at the Geneva show, are built according to the above-mentioned practice. In this particular case, however, the designers have succeeded in effecting a generally satisfactory compromise between the 1·7-litre four-cylinder, and the 2·55-litre six-cylinder models. The body, practically identical for both types, is roomy enough to accommodate six people with adequate comfort, while the engine output in either case is sufficient to provide the top speed flexibility required on the Continent. The power-to-weight ratio of the 1·7-litre model is 50 h.p. per ton, that of the 2·55-litre model almost 70 h.p. per ton, the latter figure being superior to that of the Opel "Kapitän," which has the reputation of being one of the fastest and most flexible cars of the medium-price class.

The new series, consisting of the "Consul" (Fig. 8) the "Zephyr" (Fig. 6) and its de-luxe version, "Zodiac," are new designs, though the mechanical layout, especially of the power transmission unit and of the front suspension, follows the orthodox Ford practice. The cars, larger and wider than the preceding types, have indeed "gracious" lines and a pleasing appearance; with their long, low bodies, wrapped-round wind screen and rear window, and distinctive tail fins they are examples of æsthetic styling without the excessive expense of indiscriminate chromium plate frequently seen on American cars or American-inspired "de-luxe" models.

Both engines have the same bore of 82·55mm and the same stroke of 79·5mm, the 1·7-litre engine developing 59 h.p. and the 2·55-litre engine 83 h.p., at 4200 r.p.m., with the standard compression ratio of 7·8 : 1; a low-compression cylinder head is optionally available. In compliance with the practice used in Ford diesel engines, the engines of the new series have steel caps interposed between the rocker and the stem of each exhaust valve to effect a slow rotation of the valve relative to its seat during the opening period. Another innovation is the replacement of the previous by-pass oil filter by a full-flow filter.

Concluding our description of the "Three Graces," we should mention that the new Ford models were well received in Geneva, and that most dealers agree that the "Zephyr," in particular, might well prove a best-seller at the expense, probably, of the Opel "Kapitän." The gap in the Ford range caused by the "Consul" now entering the field of larger cars, will probably be bridged in International markets by increased sales promotion of the "Taunus M.15."

Compared to the new Ford cars, which were prominently displayed in a separate hall of the exhibition building, the presentation of other British cars, though impressive by the sheer number of exhibits, was lacking in interest, the majority of the models having been known in Switzerland for some time. Nevertheless, the 2·4-litre "Jaguar," the Sunbeam "Rapier," and the restyled Standard "Vanguard," engaged the attention of the public and were favourably reviewed in press reports. As far as the "Jaguar" and the "Rapier" are concerned, these cars might well increase their sales in the category of sports cars, in which field British cars have an old-established reputation. The styling of the "Vanguard" was also appreciated, and it is believed that Standard, which some years ago commanded considerable sales in Switzerland, might be able to attract new customers with this model.

In the opening paragraphs of our article we mentioned that, in default of any other reliable standard of evaluation, the popularity of a car in free markets is a good indication, not necessarily of the absolute quality, but certainly of the functional value of the vehicle in relation to its price. Analysing the sales appeal of British cars in Switzerland (and, incidentally, in other markets of similar political and economic structure) from this point of view, we find little cause for complacency. Although our sales are practically equal to those of France, Italy and the U.S.A., we must remember that those countries are not relying on exports to the same extent as Great Britain, which—in anticipation of increased overseas sales—has spent large sums of money on extending her production capacity. Further, while our Continental competitors have been gradually building up their export trade, we have lost apparently safe markets which, with greater efforts, could have been not only held and made secure, but most probably even extended. Contrary to the expectation that the fierce competition of the French, German and Italian motor industries would stimulate British suppliers to new efforts and new successes, the fact is that such efforts, as far as they are traceable at all, have fallen short of their objective. In order to find means of checking the decline of our motor exports it seems essential to trace the reasons why British cars have lost and are still losing

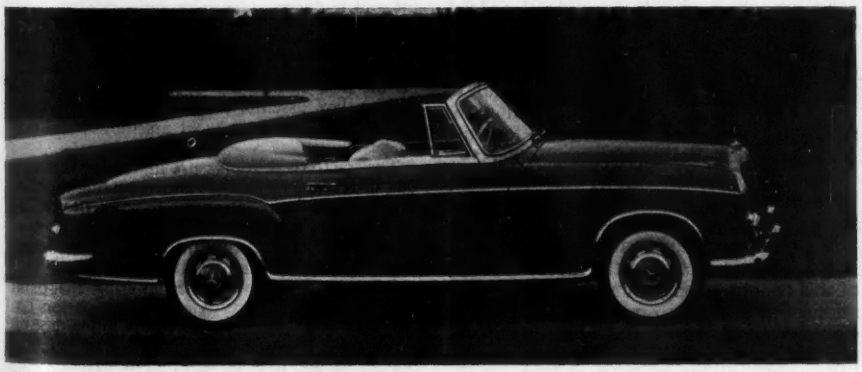


Fig. 7—A 4/5-seater Mercedes "220 A" cabriolet, incorporating the low single pivot swing-axle rear suspension

ground after several highly successful years. For this purpose we took the opportunity of interviewing at the Geneva Salon a number of Swiss dealers and several prominent motoring correspondents of Swiss, Dutch, Swedish and Belgian papers. Their opinion, summarised below, does not necessarily coincide in every respect with our own view, but it gives a fairly accurate appreciation of the position as seen through the eyes of an unbiased observer.

It is interesting to note that the criticism of these Continental experts is not so much directed towards any specific mechanical deficiencies of British cars, but towards the almost complete lack of any outstanding features in respect of either technical innovations or styling. They admit that the average mass-produced British car is mechanically sound and reliable, and that, within the limits of its basic construction, it has a creditable performance and good handling properties. On the other hand, all these qualities are so much taken for granted nowadays that they are insufficient to create additional selling points in such highly competitive markets as Switzerland, Belgium, Holland and the Scandinavian countries. In order to interest and, eventually, to attract the rather discriminating Continental customer it is not enough to build cars of merely average quality ; they have to be, in their particular price class, at least up to, and, preferably, above the standard of their respective competitors. In this respect many of the medium-priced mass-produced British cars are considered to be disappointing in their technical specifications as well as in their appearance.

Dealers in British cars, dissatisfied in their sales results, are quite outspoken in comments ranging from complaints of minor thoughtlessness to basic objections about unattractive body styling and comparatively high prices. They say that the body design of genuine British firms—in contrast to that of Anglo-American firms which favour some compromise style—looks old-fashioned and lacks that harmony of line and balance of proportion which distinguishes most Continental models. Another complaint is of the multiplicity of British models, which makes the maintenance of an adequate stock of spare parts and the organisation of an efficient after-sales service difficult. Perhaps the most serious criticism, however, is made against the general attitude of the British motor industry which, so far, has taken little interest in the European market and is still regarding suggestions from abroad as idle, ill-conceived interference. Swiss dealers, indeed, more or less imply that British motor manufacturers seem to be more concerned in producing vehicles which customers at home, in Australia, New Zealand and other Commonwealth countries are just content to put up with, than cars which are acceptable to all world markets.

Swiss and other Continental writers of technical papers also name the unattractive styling of British cars as one of the fundamental obstacles to greater sales promotion. They point out that British manufacturers, in their endeavour to preserve the so-called "British style," are actually forced to compromise between some antiquated concept and the American "new look," with the result that the adoption of some new line generally serves only to recall a style already out of date.

Fig. 8—The "Consul" Mark II ; immediately in front of the windscreen is the air intake for cabin ventilation

Most of those foreign observers who are sufficiently detached to be able to give an independent judgment are agreed in their opinion about the mechanical aspect of British car design. While conceding that the detail design of major components, especially that of engines and gearboxes, is generally good, in some cases even excellent, they are less satisfied with the general conception of our cars, which they consider out of date and lacking imagination. They blame for this lack of initiative the older generation of automobile constructors, which does not possess the artistic flair of the French designer, the scientific thoroughness of the German research worker nor the aesthetic talent of the Italian stylist.

They are asking what those groups of engineers, supposed to be engaged on long-term design and development, have been doing in the last five or six years, and are wondering that so little of their labour was reflected in the British exhibits at the Geneva show. To these observers it seems inconceivable that, in a world of ever-changing values, Britain alone should stand in splendid isolation, insisting on maintaining design principles which the Continent has already discarded or is about to discard. They criticise in particular our hostile attitude to such modern ideas as independent rear suspension, air-cooled engines, rear engine mounting, and front wheel drive : all of these were instrumental in establishing the sales success of makes like Citroen, Renault, Fiat, Mercedes, Volkswagen, and others.

We refrain from enlarging or commenting upon the above-mentioned statements of the foreign press, which, though rather generalised, certainly contain some element of truth. It must be admitted that the motor industry of this country, over-optimistic in its appreciation of the sales prospect at home and in Commonwealth countries, has given insufficient attention to improving the design of cars for the European market. Nevertheless, it would be wrong to conclude that the present recession in the motor industry should be regarded as an irrevocable development. There is no reason why the apparently fallacious idea of quantity production of conventional cars, proclaimed not so long ago as the best method of lowering prices and promoting additional sales, should not be modified in favour of qualitative improvements in design and performance of our products. Such a transition might be painful for many firms concerned, involving a great deal of drastic re-design, scrapping of outdated, and probably reduction of other models. In the end, however, the impact of foreign competition might well prove a powerful incentive : if the British motor industry can adjust itself speedily to this task, mobilising all its considerable resources of manpower and capital, it should be able to regain its position as the leading motor exporter of the world.

Tractor Assembly Line

A NEW assembly line for the "2D" tractor has been laid down at Meltham, Yorks, by David Brown Tractors (Engineering), Ltd., in a reconstructed mill shed originally used as a store by the company. With the new layout the main assembly line extends part of the way down the length of the shop, with storage and sub-assembly areas arranged along each side, and followed by priming and painting spray booths. Main stores for purchased and machined parts are situated at the side of the shop.

The "2D" tractor is comparatively light in weight when broken down into sections, and there was no need to install lifting facilities other than on and immediately approaching the main assembly line in the new shop. Pallets and fixtures are used until the tractor reaches a stage in assembly when it can be put on to its wheels; from then onwards little effort is required on the part of one man to pass the machine along the line to the finishing bay. The engine is received from the firm's Farsley works on a wheeled pallet and the gearbox also reaches the assembly line as a complete unit.

The sub-assemblies prepared in the bays alongside the main line include front and rear pillars ; linkages and airlift ; mudguards and fuel tank ; and instrument panel. The tubular main frame, which acts as an air reservoir for the pneumatic power lift is tested, in an area adjacent to the line, to a pressure of 140 lb per square inch. At a station on one side at the foot of the main line the rear axles are completely assembled and mounted on the gearboxes, and the inboard brakes are roughly set.

This assembly is transferred by hoist to the first of six stations on the line, to have the main beam fitted, followed by the front axle and wheels and rear wheel hubs. From this first station, the tractor is moved forwards on its front wheels with the rear supported on a wheeled fixture located by a centre rail. The fuel tank and mudguards are added as a sub-assembly at the second station, together with the clutch assembly, air lift and linkages, steering column and pan seat. At station three, the engine is picked up by hoist from its pallet and fitted, and the instrument panel and fuel pipes are installed on the tractor. At the next station the tractor is fitted with its rope pulley assembly, rear and centre bonnet covers, air cleaner, drawbar assemblies and rear wheels.

The tractor is next pressure-lubricated throughout, its oil reservoirs filled, and diesel fuel supplied to the main tank. Before removing the trolley to allow the tractor to run forward on its own wheels, the engine is run, the gearbox tested, and the brakes are adjusted and balanced.

Prior to the tractor then entering the paint spray booths, masking is applied at station six. An open area adjacent to the painting booths serves as a bay in which a number of finishing operations and tests are carried out. The steering wheel, gearbox lever knob, name plates and dirt excluders are affixed prior to setting of the air lift and tracking-up of the front wheels.

Institution of Naval Architects

ANNUAL SPRING MEETING

No. V—(*Concluded from page 417, April 27th*)

FURTHER abstracts from the discussion of Mr. Ramsay's paper "Aspects of Ship Vibration Induced by Twin Propellers" are reproduced here:—

Mr. P. W. Ayling: With regard to the theoretical prediction of hull criticals, I feel that in merchant work this is considered to be of more than academic interest, particularly when attention must be given to horizontal and torsional modes as well as vertical vibration.

A section of the paper deals with a vibration generator survey of a destroyer in harbour. Does Mr. Ramsay consider that the experimental results were affected due to the fact that the vessel was berthed alongside, and has he any further comments on the similarity of the results at high and low water? According to published evidence, frequencies for vertical vibration may be affected when the depth of water is less than five times the draught. Even at high water the destroyer in question was in water of approximately only three times the draught. Using an expression due to Prohaska, the percentage change in the added virtual mass in shallow water would have been approximately 8 per cent at high tide and 17 per cent at low tide. These figures indicate that the experimental critical frequencies may vary by between 2 per cent and 4 per cent when compared with results which might have been expected in deep water.

Regarding the possibility of local resonance at the exciter, would the author explain why, if this was the case, he would have expected the response to decay at the rate of 6 dB. per octave. I cannot understand how the response above 450 c.p.m., if it is made up of the residues from the previous modes, can be higher than about the 0·002in double amplitude at 410 c.p.m., and I am intrigued by the conjectural peak at 430 c.p.m. It would be instructive to know what information was given by the pick-up situated at the exciter at this point in the frequency range.

Coming to the conclusions which deal with this apparent breakdown in the response of the hull, my impressions are that the findings seem somewhat sweeping when based on the results of only one exciter trial.

Would it be correct to infer from the conclusions that, in warships which normally steam at not less than 150 shaft r.p.m., attention need not be focused on the first few critical frequencies, but on a response which remains sensibly constant over a wide range of frequency?

Mr. S. G. Lankester: The author mentions the possibility of the local wake of shaft bracket arms or bossings giving rise to large forces, mainly in the transverse direction. In Admiralty designs care is taken to ensure the best alignment of shaft brackets and thereby reduce local wakes to a minimum. In a ship with bossings as opposed to "A" brackets there is increased danger of a local wake. A wake survey, mentioned in a paper by Dr. Todd to the British Association in 1938, shows quite a considerable wake "shadow" in way of the bossing. This was at an angle in excess of 45 deg. to the vertical, so that there would have been a vertical reaction nearly as large as the horizontal component.

Experience has shown that ship vibration can be minimised, not only by paying attention to adequate hull clearance, but also by propeller blade form and gradual wake penetration.

Fig. 5 in the paper suggests that, at 20 per cent tip clearance, the vibration may be reduced at source in the ratio of 3 : 10 by increasing the number of blades from three to five. Since the frequency is increased and since acceleration (which may be the most important criterion) is proportional to the square of frequency, the reduction in acceleration is only 75/90, which is not significant.

The final session of the spring meeting, on Thursday afternoon, March 22nd, was held jointly with the Institute of Marine Engineers, with Sir Stanley V. Goodall in the chair, when the following paper was presented :—

THE CORROSION OF CARGO SHIPS AND ITS PREVENTION

By H. J. Adams and Dr. J. C. Hudson

Synopsis

There is a general discussion of the problem touching upon the occurrence of corrosion, the effect of steel quality and of design, and the liability to corrosion by welding. Corrosion of underwater plates is examined, beginning with examples provided by practical experience followed by remarks upon the mechanism of sea-water corrosion, suggested remedial measures and notes on protective painting. The latter discuss such items as current practice, maintenance painting, methods of application, research on anti-corrosive bottom compositions, metallic coatings, anti-fouling compositions, and rivets and welds. The paper deals with the corrosion of superstructures and then reviews the question of internal corrosion, mentioning those places where it is most liable to occur and including remarks upon air conditioning and protective measures.

Discussion

Dr. S. Livingston Smith: The authors state that paint removal is one of the commonest reasons for corrosion, and no doubt the turbulence of the water plays an important part. Maybe the most important position for this to occur is at the sternpost and rudder in single-screw ships; these are directly in the screw race and are subject to the scouring action of the water. The probable action is that after entering into service a hydraulic blast from the screw tears off the protective coating of paint, and a galvanic action is set up between the bronze propeller and the bare steel. Next the scouring action of the screw race washes away the corrosion products and supplies more oxygen, and the result is a most efficient corrosion mechanism.

The incidence of corrosion on the stern frames and rudders of single-screw ships is greater now than before, and that is probably due to the tendency to put more power on to a single-screw shaft, producing more hydraulic blast and the increase of shaft r.p.m.

Mr. J. Barrington Stiles: Under the heading of surface preparation of superstructure it is said that maximum paint durability is secured by putting the first coat of paint on to a clean steel surface free from millscale and rust and that the best practical way of securing this is by pickling or grit-blasting. I qualify the statement by saying that it applies only to protective systems which are exclusively paint. Where it is economically practical a system involving grit-blasting and metal spraying provides a base which will improve the durability of a subsequent appropriate paint treatment. Zinc and aluminium, when sprayed, provide an ideal base for paint, their surfaces are matt and have an order of roughness comparable with a grit-blasted surface, and the pores in the sprayed metal absorb a certain amount of a priming coat so that the paint is mechanically locked to the surface.

Metallised hulls have been confined to barges, fishing vessels and yachts, but the steady increase in the volume of such work must be some indication of customer acceptance, and I am expecting to see larger vessels tackled in the very near future. The protection of steel hull yachts throws emphasis on the appearance factor, in which the substantially lower cost of maintaining a spotless condition can offset the initial extra. The position of cargo vessels generally falls somewhere between these two, but it should involve a degree of both these economies. Metallising is being speeded up. Using $\frac{3}{16}$in diameter zinc wire, a coating 0·010in thick can be applied to a hull at upwards of 1000 square feet per nine-hour day. What does this mean in terms of cost? If the authors' recommendations regarding grit-blasting are accepted as a preparation for painting, then the additional cost of metallising with zinc is only the cost of the zinc wire plus about 20 per cent for labour and the material used to apply it.

The authors appear to favour brush painting but experience indicates that for the matt condition of grit-blasted or metal-sprayed surfaces, it is best to spray the paint. Brushing is satisfactory but rolling is an extremely doubtful method.

Wear and tear on plates is often referred to as abrasion of the steel when it is in fact a cycle of formation, removal and reformation of corrosion products. In my 1948 paper to the Institute of Marine Engineers I referred to a pre-war example of sprayed zinc. A dredger had part of its deck metal-sprayed where the action of salt water plus abrasion by ballast falling on the decks during unloading had thinned the deck plates until there was danger of failure. The vessel discharged ballast nightly, polishing part of the deck in so doing. On the following day, on putting to sea to refill with ballast, the deck rapidly rusted, so that the cycle of rusting and polishing was in operation daily. It was considered that zinc might not sufficiently well resist abrasion; but the comparison was not between zinc and steel, but between zinc and rust. The zinc spray was regarded as highly experimental but was still (in 1948) giving good service.

Mr. J. M. Murray: It is doubtful whether the evidence on the wastage of old and new ships is relevant to ships building at the present time. During the thirty years to 1930 there were few changes in the methods of steel production; it is subsequent to 1930 that the modern fast rolling mill was introduced, and with it a different type of millscale. It does not follow, therefore, that because there was no difference in the wastage of ships built between 1899 and 1914 and those built between 1926 and 1930 the same situation exists to-day. We shall need to wait for another twenty years before we know the answer.

My experience has been that much of the corrosion of outer shell plating can be attributed to the imperfect removal of millscale. I am pleased that the authors have not mentioned an explanation which is often put forward and which has no foundation, that of stray electric currents from the ship's generators. A few years ago I inspected the *Queen Mary* and was much impressed by the underwater surface. The state of the steel was excellent, the edges of the

seams and butts were unusually sharp for a ship of her age. No doubt the very complete weathering process to which the ship was subjected during construction was in some degree responsible for the excellent condition of the bottom.

I was under the impression that the main advantage of applying paint by brushing was that any small beads of moisture on the surface of the steel were worked through the composition to the surface, where they evaporated, whereas when rolling or spraying was used the moisture was entrapped under the surface of the paint.

Mr. Jones : The term " relative humidity " appears to be used as a basis concerned with the possibility of rusting. Relative humidity must be related to something, and is in fact defined as the ratio of the actual vapour pressure of the air to the vapour pressure of saturated air at the same temperature. In other words, " relative humidity " means little until it is related to air temperature.

Internal corrosion, where not necessarily associated with salt spray or corrosive cargoes, is caused by condensation on the surface of the steel in the presence of oxygen in the air, and, therefore, if at any time the cargo or structure of the ship is at a temperature below the dewpoint of the surrounding air, condensation results and corrosion can occur. There is a rule which can be applied to ships' holds ; it is that when the outside air dewpoint is below the inside air dewpoint, maximum ventilation should apply, and where the inside dewpoint is less than the outside air dewpoint, air recirculation or closure should be applied. If dehumidifying plant is fitted, it enables the dewpoint of the air inside the holds to be kept down.

Another source of condensation in holds is the proximity of refrigerated spaces. This trouble has been overcome successfully by the use of " thermal injection," which is the application of low-voltage electric heating.

Mr. G. A. Bassett : The preparation of surfaces is the all-important matter in this problem, and use of a quick method results in trouble. Some work has been done to increase the practicability or possibility of using sand-blasting in shipyards ; it is the best method of preparation we could have.

There is difference of opinion as to whether, when you have sand-blasted a ship, you should put the inhibitor coating on straight away or wait a month. The *Queen* ships were descaled to the water line, an inhibitor coating base put on and the descaled area not left uncovered overnight. The result on the *Queen Mary* was first-class, and due largely to the care taken to carry on a continuous process, descaling as trouble arises.

Mr. J. A. Shepherd : The development of the protection of hulls by zinc spraying has been retarded only by the one-time difficulties associated with shot-blasting and the high cost of zinc plus the reluctance of shipowners to " experiment " with a process not already established. Sufficient evidence is now available, however, to show that a layer of zinc on the suitably prepared hull of a vessel, subject to either fresh or salt water, will provide protection out of all proportion to its initial cost.

The *Beta III* is an example of a vessel subjected to the worst conceivable corrosive conditions the waters of Britain can offer, yet with the minimum of maintenance shows virtually no corrosion over the last twelve years. In 1944 she was metallised inside and out with 0·005in of pure zinc. During the last nine years the hull has been painted once, above the water line and in the fore and aft holds, and the bottom had received a few coats of bitumastic paint. There is no sign of corrosion, or lifting of the paint film; the frames are in perfect condition and the rivet points show no sign of pitting.

Mr. Stevens : I underline the need for careful surface preparation and the application of paint in good weather conditions. A great deal of effort has been and is being devoted to the improvement of paints, but I feel that a great deal of that effort will be wasted if that counsel is not heeded.

It is stated that the Admiralty normally hot-galvanise ship plate of ¼in thickness or less; we regard it as the right thing to do, but that procedure has been restricted to some extent. The fabrication of structures in galvanised plating presents a number of extremely difficult problems, one of which is that the areas where protection is most needed after welding are just those where the zinc no longer exists. The authors point out that so far as the outside of the ship is concerned, the coating elsewhere will tend to protect the bare steel areas cathodically. But much of the corrosion occurs inside what are called " dry " compartments, and there can be liquid contact between the unprotected areas and those galvanised.

Mr. C. V. Manley : This problem is age-long ; it existed with iron ships, and it was discussed in a paper presented to the I.N.A. by Mr. Robert Mallet in 1872. One of the remedial measures advocated in those days was the copper sheathing of iron hulls, but was not proceeded with, due to defects regarding the method of attachment. One protective coating which apparently was found to be effective was that of long boiled coal tar, laid on when the iron was hot.

It is striking that, by way of practical suggestion, the present authors repeat the advice given by Lloyd's Register in 1888, when steel ships first began to be built.

Professor E. V. Telfer : I do object to the use of the word " holidays " in paint. However, according to the Oxford dictionary, the definition is " A small gap in a tarred surface of a ship, generally not exceeding a quarter of an inch," so that nautical people are responsible. The next terminological quarrel concerns the use of the word " turbulence." Turbulence does not produce corrosion or erosion. The whole ship is working in turbulent water, and the greater part is perfectly free from corrosion and erosion. What the authors mean is that an eddying flow or flow consisting of vortices impinging on various parts of the structure will cause excessive corrosion. Consider the stern frame, rudder and propeller. A rudder correctly streamlined in relation to the angle of flow, properly considered in relation to distance, will be as smooth after ten years' service as when it was first fitted. Vortices cause excessive aeration of the water, and there is very high concentration of oxygen release.

Mr. Tait : I have been concerned with the protection during the fitting-out period of about a score of ships, and I do not think that any ship examined so far, which has been protected cathodically during the fitting-out stage, has shown any pitting or corrosion of the steel when docked and examined. In the discussion of the paper by Carter and Crennell last year I mentioned two cathodically protected ships. One of them has now been at sea for twenty-nine months and was inspected two or three months ago and the other has been protected since launching ; there is no trace of corrosion on any part of those ships below the water line.

There is a suggestion that the provision of cathodic protection apparatus might impair the efficient working of a ship. I do not think that any master or chief engineer on any cathodically protected ship in service even knows that he has the equipment fitted.

I think the problem of the protection of oil tankers is now one of reducing urgency, about 130 tankers are so protected and are being equipped at an increasing rate. I think the time will come when the corrosion of oil tankers will be largely of academic interest.

Mr. Sherley : The authors seem to dismiss the stainless steels from the marine sphere ; none of us would think of producing a whole hull of stainless steel ; but for propeller shafts and propellers these materials, if properly designed, have behaved well.

Mr. W. A. D. Forbes : Corrosion fatigue is not dealt with specifically in the paper. During the last few years the Admiralty Corrosion Committee has had to consider a number of instances of the corrosion fatigue of outer bottom plating, and I think that this form of corrosion is more prevalent than is generally recognised.

In general, corrosion fatigue in outer bottom plating starts in the form of a multiplicity of hairline cracks which, once set up, rapidly deepen and weaken the plating. It is probable that the plating of merchant ships, being thicker, is less liable to this type of failure than that of warships, but merchant ships are more liable to this trouble with the propelling machinery, shafts and rudders, since they spend a far greater portion of their lives under full power.

New Fuel Oil Applications

A PAPER entitled " New Fuel Oil Applications," was read before the Institute of Fuel on April 4th, by T. Chippindale. The rise in the industrial use of oil fuel is noted, the consumption for the years 1938, 1947 and 1955, being given as 1,425,700 tons, 3,498,800 tons and 7,750,000 tons, respectively; the latter figure is expected to rise to 22,000,000 tons by 1960. Developments mentioned include the production of self proportioning burners, having a turn-down range of 5 to 1, and high intensity combustion chambers with a heat release of 1,000,000 B.Th.U. per cubic foot per hour compared with the more normal amount of 70,000 B.Th.U. Another high heat release air-cooled combustion device mentioned is the " Combustor " designed for fuel flows ranging from 3 gallons to 125 gallons per hour or 20,000,000 B.Th.U. For rotary pin-heating furnaces there are now high intensity burners of which the small units have a turn-down of 2 to 1, while the larger sizes have a 5 to 1 turn-down. It is stated that oil fired radiant tubes known as " Jetubes " have been developed with a combustion chamber heat release of 1,000,000 B.Th.U. per cubic foot per hour, while medium pressure, low capacity air burners have been fitted with a forced secondary air casing to give a turn-down range of 8 to 1. Oil firing, the paper states, has been applied to Kemp tube immersion heaters and another item described is the drip feeding of brick kilns which includes plain drip feed and forced injection systems. In the latter, oil is supplied to each feed point at about 150 lb per square inch. Oil is also being used for firing tunnel and intermittent kilns because of its high flame temperature, and another development mentioned is the O.C.C.R. oil gasifier which has a 4 to 1 turn-down and is made in sizes having capacities ranging from 6 gallons to 250 gallons per hour.

PUBLIC SERVICE VEHICLES.—Under the Motor Vehicles (Construction and Use) (Amendment) Regulations, 1956, the maximum length of four-wheeled, double-decked vehicles, if registered before July 1, 1956, will be 27ft, and if after, 30ft, the latter figure being common to all public service vehicles. On that date the maximum laden weight of a four-wheeled public service vehicle will rise from 12 to 14 tons and the two-wheel axle weight of any public service vehicle from 8 to 9 tons, the same figures as apply to goods vehicles.

Keadby Power Station

Sir Henry Self, Deputy Chairman (Administration) of the Central Electricity Authority, opened, on April 20th, the 360MW generating station at Keadby. The plant consists of six 60MW hydrogen cooled turbo-alternators and boiler units, pairs of which share chimneys and some auxiliaries. The stop-valve steam conditions are 900 lb per square inch and 900 deg. Fah.

KEADBY power station of the Yorkshire Division of the Central Electricity Authority occupies an area of over 180 acres near the junction of the River Trent and the South Yorkshire Navigation. One site of 48 acres is occupied by the circulating water pump house, near to the Trent, the main buildings, seen in Fig. 1, and an open-air substation. The Grid transmission lines run to the west, in which direction lies a second site devoted principally to coal handling and storage. A railway and three roads lead into the station, and coal can arrive by either means. The subsoil proved to be sand, silt and clay, and it was necessary to drive piles an average of 50ft into Keuper marl to support the structure. About 4900 piles carry a reinforced concrete base slab, which is about 8ft below the basement floor proper, the intervening space accommodating pipework and cables. This basement floor has a "Granolithic" finish, but the turbine house floor, 30ft higher, is tiled with terrazzo. The steel structure of the building is concealed by this tiling for 8ft from the floor, above which it is shrouded in a sound absorbent sheath of wood overlaid by glass wool, a sheet of linen, and decorative panels of perforated aluminium anodised a glowing pale pink colour. The trusses of the roof carry a false ceiling of cellulose fibre blocks in between the large lantern lights, and, as a result, a noise level permitting at least brief conversations obtains in the turbine room. The roof of the boiler-room is higher by about 40ft, and contains smaller windows: in both cases the windows can be opened under remote control. The three 325ft chimneys and the buildings for offices and circulating pumps are of load-bearing brick construction.

Double tracks and separate sidings for full and empty coal wagons are provided. There are four combined wagon tipplers and weighers, each handling up to twelve wagons an hour, with up to 21 tons of coal in each. Road vehicles discharge coal on to the storage area, where three bulldozers pile it and move it as required to the reclaiming hopper which delivers into the main conveyor system. The conveyors range up to 48in wide, handling 250 tons per hour at 340ft per minute, and the longest have belt centres of 561ft. Two pairs of single-deck vibratory screens divert to two flexible tooth crushers any coal too large for the pulverising mills. Magnetic separators are also included in the conveyor layout. Four pulverising mills are allotted to each boiler, an output of 9 tons per hour with 8 per cent moisture content allowing three of these to meet the normal fuel requirements. Heated combustion air, drawn from the top of the boiler house by the forced draught fans and passed through Ljungstrom regenerators, is pressurised by the primary air fans to carry the pulverised fuel to the eight burners in the roof of the furnace. Combustion takes place in a chamber lined entirely with water tubes, the exhaust gases passing out at the bottom of the chamber and rising through the superheater and economiser banks. Except on No. 6 boiler, the third section of the economiser is in the exhaust duct on top of the boiler.

"Centicell" dust collectors precede the rotary regenerators, and the gases then pass through electrostatic precipitators and are expelled to the chimneys by the induced draught fans. These, like the f.d. fans, run at constant speed, the inlet vanes being set by the automatic combustion control equipment. The furnace volume is 22,650 cubic feet (25,500 cubic feet for No. 6) and the coal consumption 60,700 lb per hour for a heat release of 15,580 B.Th.U. per cubic foot per hour (14,150 for No. 6). A set of automatic steam soot blowers is operated once every eight hours, and ash is removed from the bottom of the furnace by a "Hydro-Jet" system. Ash from the furnaces, the centrifugal separators and electrostatic precipitators, and from hoppers at the base of each chimney, is carried by sluiceways to an ash sump, that from the furnaces passing through one of two crushers. From the sump the mixture of ash and water is drawn by four horizontal centrifugal pumps, pairs being piped in series, and delivered through a 1½in thick cast iron pipe with a length of up to 2300 yards. This pipe leads to the ash ponds, in which the solid matter settles out, the water being returned through a 24in concrete pipe to the storage pond outside the boiler house. These ash ponds are simply areas of land surrounded by dykes, from which the top soil has been removed. The first two, of 6¼ and 5¾ acres, accepted 140,000 tons and 90,000 tons of ash, and the top soil was replaced and seeded with grass. Two ponds of 15½ and 20½ acres now in use are expected to accept 300,000 and 410,000 tons of dust and ash. Recently, the station has been burning 24,000 tons of coal each week and disposing of 4800 tons of ash, while certain batches of coal were successfully burnt with an ash content of 41 per cent. It can be accepted that ash disposal is a matter of some importance, and it is considered that in this area the building up of land by inserting a sub-soil of ash may enhance its value by rendering it immune from inundation by brackish water.

The boiler furnaces are lit-up on oil fuel, 30,000 gallons being stored on the site and heated electrically before feeding at 250 lb per square inch to the eight atomisers in each boiler. Automatic ignition and retracting devices are provided.

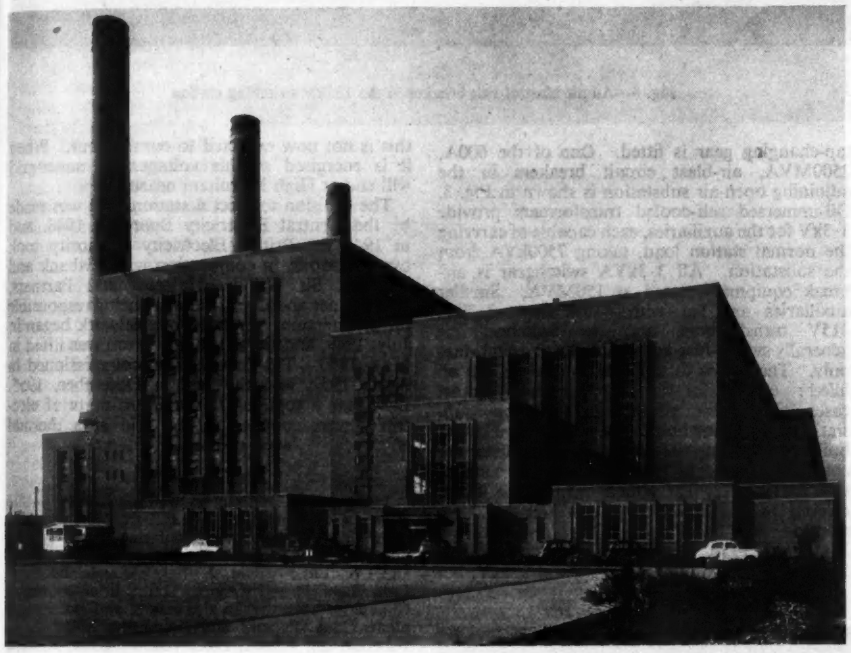


Fig. 1—Eastern aspect of Keadby power station. The administration building in the foreground is connected to the turbine house by an enclosed bridge at second storey level

Steam Generating Plant

All water is taken from the River Trent, which is here tidal and heavily charged with suspended silt and mud. Make-up water is first subjected to flocculation treatment, remaining in Aitken tanks for 1½ hours, and then passing through sand and anthracite filters. Four 25,000-gallon tanks store filtered water, which is fed to an auto-blended base-exchange water softening plant handling 10,000 gallons per hour. Since the salt content of the river is often up to 30 per cent, the softening plant may have to be shut down for long periods, and so there are four 25,000-gallon and one 250,000-gallon tanks accumulating soft water.

Softened water is evaporated in three live steam triple effect thermo-compression evaporators for use as boiler make-up. There are no steam feed pumps: each pair of boilers has three electrically-driven six-stage pumps, one of which can act as standby for either of the others. Two low-pressure and three high-pressure stages of feed heating provide a final water temperature of 385 deg. Fah. at full load. The boilers steam at 925 lb per square inch, and are radiant single drum units, the drum being a fusion welding weighing 63 tons. This drum, together with the rest of the heating surfaces and the boiler casing, hangs from the steel structure of the boiler house, the weight of each unit being 1524 tons, including 84 tons of water. The height from ash hopper to suspension is 108ft 6in, and to allow for expansion there is a water seal around the casing where it meets the ash hopper. Relative movement is about 4½in, and where catwalks are attached to the casing, hinged gangways lead from them to the structure of the building. Three-inch tubes surround the combustion chamber, and constitute a central dividing wall, there being 16,330 square feet of surface in all except unit No. 6, which has 20,350. On the updraught side of the boiler, the primary superheater has two banks of 2½in O.D. tubing, of ½ per cent molybdenum steel, arranged in contra-flow. The secondary superheater has two banks of "Esshete" tubing, except in No. 6, where three banks of chrome molybdenum tubing are used. Between the two stages, there is a spray type attemperator. The spray volume is governed by the automatic boiler control gear: normal output temperature is 915 deg. Fah. Above the superheaters is a continuous loop steaming type economiser, having two internal and one external banks of 2½in O.D. tubing, except for No. 6, which has three banks, inlet and outlet parallel flow, centre contra-flow. Two steam mains lead to the two throttle valves of each turbine, there being a common inlet tract so that the throttles do not need to be perfectly matched. Between each boiler and its turbine there is a control board for them, as seen in Fig. 2, the left-hand panel carrying turbine instruments and the remaining

two being devoted to the boiler. Some turbine supervisory gear, including an indicator of eccentricity, appears on a separate smaller panel. The turbines have a continuous maximum rating of 60MW at 900 lb per square inch, and 900 deg. Fah. Reaction blading of stainless steel is used throughout, there being nineteen stages in the high-pressure and intermediate-pressure cylinders and six in each of two flows in the low-pressure cylinders. The condenser vacuum is 28·7in of mercury in sets Nos. 1 to 3 and 28·9 in the remainder, maintained by three two-stage main ejectors : a single-stage "Quick Start" ejector is also fitted. There is a shunt de-aerator, capable of handling approximately one-fifth of the feed water, for each set. The condensers are cooled by 2,700,000 g.p.h. of river water, induced through water-washed continuous band screens by pumps with a head of 45ft. The pumps are always below and the motors always above river level : as the range of the tide is 19ft 6in, extended shafting is called for. Three lines of 6ft steel pipe, bitumen lined, lead from pump house to power station, and three similar lines back to the river three furlongs downstream. Some 60,000 square feet of tube surface is provided in each single-shell divided two-pass condenser, provision being made for each half of the water side to be cleaned separately. The tubes, ¾in diameter, are cupro-nickel in sets Nos. 1 to 3 and aluminium-brass in the others. So effective is the scour of the silt-laden water that the liquid chlorine plant intended to combat algae on the tubes has been found unnecessary : the ends of the tubes, however, suffered some erosion. Ferrules of "Alkathene" are now fitted in the tubes, and suppress this effect—although if a foreign body jams in the ferrule, the polythene is rapidly destroyed.

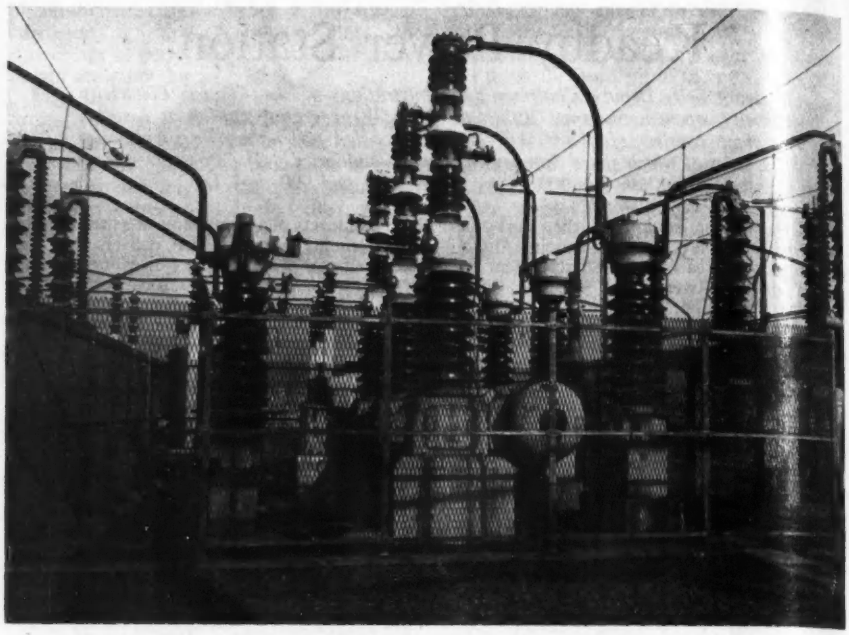


Fig. 3—An air blast circuit breaker in the 132kV switching station

Electrical Plant

The generators run at 3000 r.p.m. and 11kV for sets Nos. 1–3, 11·8kV in the remainder. The alternators are cooled by hydrogen at ½ lb per square inch above atmospheric pressure, the hydrogen giving up its heat, at 140 deg. Fah., to distilled water in heat exchangers. In sets Nos. 5 and 6 the rotors are direct cooled. Main and pilot exciters run at close to one-third line speed, there being a hunting tooth in the drive. Each generator is connected solidly to a transformer which steps up its output to 132kV. The transformers for sets Nos. 1–3 are rated at 75MVA, and the remainder at 72MVA, this being the new standard rating for this size of turbo-generator. These transformers are oil-immersed force-cooled with two water coolers each, one being a standby to the other : on load tap-changing gear is fitted. One of the 600A, 2500MVA, air-blast circuit breakers in the adjoining open-air substation is shown in Fig. 3. Oil-immersed self-cooled transformers provide 3·3kV for the auxiliaries, each capable of carrying the normal station load, taking 7500kVA from the substation. All 3·3kVA switchgear is air-break equipment, rated at 150MVA. Smaller auxiliaries are fed with 415V from 3·3kV, 415V transformers, and the switchgear is generally switch-fuse and contactor or switch-fuse only. The cables to the 132kV breakers are oil filled : cabling for lower voltages has in most cases aluminium sheathing. Between sub-station and power house is a circular brickwork building enclosing the control room ; hence are controlled all the 132kV switchgear and some of that for 3·3kV. The panels include one linked directly to South Stella by the super-grid, now running at 132kV. As we recorded on January 6, 1956, page 21, it was intended that Keadby should supply this system at 275kV, but this is not now expected to come about. When it is energised at this voltage, the super-grid will end at High Marnham nearby.

The decision to erect a station here was made by the Central Electricity Board in 1946, and in 1948 the British Electricity Authority took over the work, in conjunction with Ewbank and Partners, Sir William Halcrow and Partners, and Farmer and Dark, the latter being responsible for architecture. Erection of steelwork began in July, 1949, and the first boiler drum was lifted in May, 1950. The first set was commissioned in April, 1952, and the last in December, 1955. Last year a total of 2000 million units of electricity were supplied to the grid at a thermal efficiency of 28·60 per cent.

Fig. 2—No. 2 turbo-alternator; beyond the control panel can be seen the boiler, while in the foreground are the feed water heaters and de-aerator storage tank

Main Contractors

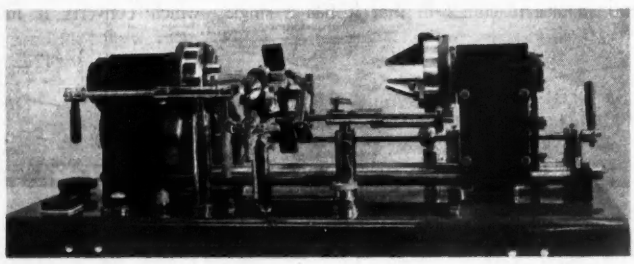
The principal contractors were as follows :—Site clearance and building, Sir Robert McAlpine and Sons (Midlands), Ltd.; circulating water system, Stewarts and Lloyds, Ltd.; penstocks, Ham Baker and Co., Ltd.; valves, J. Blakeborough and Sons, Ltd., Glenfield and Kennedy, Ltd.; brick chimneys, Chimneys Ltd.; turbo-alternators and condensing plant, C. A. Parsons and Co., Ltd.; boiler plant, Babcock and Wilcox, Ltd.; coal weighers, Richard Simon and Co., Ltd.; electrostatic precipitators, Sturtevant Engineering Company, Ltd.; coal-handling plant, Spencer (Melksham), Ltd.; tractors, John Fowler (Leeds) and Co., Ltd.; dozers, carrier scraper, Blaw Knox, Ltd.; cranes, turbine room 140-ton, Cowans, Sheldon and Co., Ltd.; electric overhead, The Wharton Crane and Hoist Company, Ltd.; hand overhead, Vaughan Crane Company, Ltd.; electrical equipment, Electro Mechanical Brake, Ltd., Ed. Holme, Ltd., Dewhurst and Partners, Donovan Electrical Company, Ltd.; lifting tackle, Herbert Morris, Ltd.; road weighbridge, Ashworth Ross and Co., Ltd.; external fire-fighting installation, Merryweather and Sons, Ltd.; interior fire-fighting installation, Mather and Platt, Ltd.; ash-handling plant, Babcock and Wilcox, Ltd.; low-pressure pipework, Brightside Foundry and Engineering Company, Ltd.; circulating water chlorination plant, Wallace and Tiernan, Ltd.; water softening plant, Permutit Company, Ltd.; thermal insulation, Darlington Insulation Company, Ltd.; central evaporating plant, Aiton and Co., Ltd.; locomotives, Andrew Barclay and Sons, Ltd.; diesel locomotives, Hudswell Clarke, Ltd.; transformers, C. A. Parsons and Co., Ltd.; switchgear and controls, 275kV, 132kV, 3·3kV, A. Reyrolle and Co., Ltd.; auxiliary switchgear, unit boards, control boards and station board, English Electric Company, Ltd.; 415V switch fuse gear, Electro-Magnetic Mfg. Company, Ltd., and Yorkshire Switchgear and Engineering Company, Ltd.; 415V contactor gear, Contactor Switchgear Company, Ltd.; cables, W. T. Henley's Telegraph Works Company, Ltd.; telephones and alarm equipment, direct-wire system and p.a.x. system, Automatic Telephone and Electric Company, Ltd.; diesel fuel pump and tank, Wayne Tank and Pump Co., Ltd.; batteries, Nife Battery Co., Ltd.

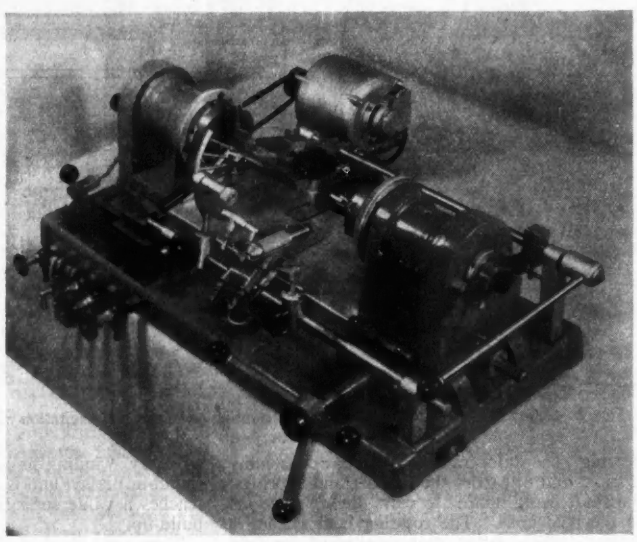
Novel Glass Working Machine

Details are given of a machine designed to produce a wide range of glass parts, and to carry out laboratory glass-working operations rapidly and with increased accuracy.

THE laboratory glass blower usually employs simple hand tools and relies upon a high degree of manual skill to fashion glass into the many complex forms required in the laboratory. This approach persists even in the face of the many technical advances found in industrial glass-working, e.g. those in the electric lamp and valve industries. Although the technical processes employed in these industries are based, in the main, on the mechanism of what were previously manual operations, the new outlook has not been applied, so far, in the laboratory. This is probably due to laboratory technicians being unduly impressed by the variety and complexity of laboratory glass work, and by their failing to appreciate the many underlying similarities of the work. Every piece of lamp blown glass apparatus is formed or built up from one or more basic forms, e.g. bulbs, cones, various kinds of joint, seals, &c., each of which could be produced more precisely and more rapidly by a suitable mechanical aid, the whole apparatus being finally assembled by hand. Furthermore the advantages of mechanisation would be most apparent in those cases where speed is important and where repetition is involved.

With these points in mind, a prototype glass-working machine was designed and built at the British Coal Utilisation Research Association's laboratories at Leatherhead, primarily as an aid for their own glass-working department. This machine, which is more versatile than the conventional glass-working lathe, can deal with all but the larger and heavier work in either soft or hard glasses ; also it is such that a semi-skilled operator can cope with specialised work which otherwise would occupy the time of a skilled glass blower. Since it was realised that the new machine could have many applications outside the Association's own laboratories, the possibility of its commercial production was investigated. Edwards High Vacuum, Ltd., of Manor Royal, Crawley, Sussex, working in close collaboration with B.C.U.R.A., has developed, and is now manufacturing, a production model. Further reference to the commercial product will be made later on in this article.





These laboratory glass-working machines are capable of producing a very wide range of laboratory glassware. The design was developed at the British Coal Utilisation Research Association's laboratories. The prototype model is illustrated above and the production model below

Prototype Machine

The B.C.U.R.A. prototype consists essentially of a head and tailstock synchronously connected, and between which the work rotates, thus overcoming one of the principal difficulties of manipulation. Gas burners are arranged adjacent to the work, and these and the flame conditions can be preset. The tools also are arranged so that only the desired direction of movement is possible. As a result of these provisions only the very minimum of manual skill is required for effective glass-working. A push or pull movement is all that is involved, and even this is further assisted by adjustable stops and visual indicators. The prototype machine handles glass tubing up to 1¼in in diameter through the chucks, and short lengths of work up to 3in in diameter. The maximum work diameter permissible is 4½in and the clear working space between the extended jaws of the two chucks is approximately 10in.

In the B.C.U.R.A. machine a steel base supports a fixed headstock and a traversable tailstock, the latter being operated by a control lever. The work speed range is approximately 120 to 150 r.p.m., the geared motor having a continuously-variable speed control. An adjustable burner bar runs in front of the work, and arrangements have been made for fitting on to this a wide range of interchangeable gas burners. Carbon and metal forming tools, which are interchangeable, are supported by other slide bars and are easily controlled by the handles provided.

The driving motor is controlled by an on/off switch and a speed control knob, both of which are to the extreme left of the machine, as viewed by the operator ; gas, air and oxygen valves are also adjacent. Rubber tubes convey the gas, air and oxygen to the machine and are grouped together on its left-hand side. Thus they are clear of the work and the operator, whose left hand is able to control the flow of gas to the burners and the rotation of the work. As these controls are only used intermittently, the left hand is normally free for burner positioning and occasional hand tool work. The upper view shows the B.C.U.R.A. prototype machine, and below it the commercial development is illustrated. The two are similar in principle, the only significant difference being mechanical variations and the substitution of gearing for a resistance in the speed control.

The Commercial Product

Since the development of the prototype, commercial production of the new glass-working machine has been undertaken by Edwards High Vacuum, Ltd. The machine is mounted on a cast iron base and has a fixed headstock and a traversable tailstock operated by a conveniently situated handwheel. The rotating mandrels are synchronously driven and are compensated for backlash. All shafts run in easily replaceable ball bearings, while the main working parts of the machine are protected from radiated heat by a sliding metal cover. The drive to the machine is taken from an integrally mounted ¼ h.p. electric motor, and the mandrel speed is immediately, infinitely variable from 120 to 500 r.p.m. An adjustable burner mounting bar runs in front of the machine, a gas supply point for two burners being located to the left of the base. Two burners—a cannon type and a crossfire type—are provided as standard equipment, but other burners can be supplied if required. By suitable combinations of burner and tool a very wide range of glass forming operations can be carried out.

Operation

To operate the machine the work is positioned in the headstock chuck and, if internal air pressure is needed, the necessary swivel is fitted and connected up for mouth or compressed air blowing. Gas burners to provide the size and type of flames required for the work in hand are arranged in the correct position relative to the work, and the necessary forming tools are set up. The motor control is set to rotate the work at a suitable speed, and the burner and forming tools are manipulated to carry out the desired operations. If desired, a time programme may be worked out to simplify and speed up the production of repetition work.

British-Built American Automatics

Some time ago the Brown and Sharpe Manufacturing Company of the United States decided to manufacture machine tools in this country, and as an initial step placed an order for a hundred No. 00G automatic screw machines with the Mollart Engineering Company, Ltd., Kingston By-Pass, Surbiton, Surrey, on behalf of a newly-formed British subsidiary, Brown and Sharpe, Ltd. For the construction of these machines the American firm supplied a certain number of the necessary jigs, tools and gauges together with a few essential components. Production of machines was started about a year ago, and recently the first two to be completed were demonstrated to a group of representatives from firms distributing Brown and Sharpe machines in Europe. The new machines are made throughout to Brown and Sharpe standards, tolerances and material specifications, so that all their parts are completely interchangeable with those of American-built machines.

For the construction of component parts of the automatics a number of new machine tools were installed and equipped with the necessary jigs, fixtures and other tooling in the machine building section of the Mollart works, and special assembly lines laid down. Sub-assemblies are built up on benches and delivered as required to the main line, where the machines are built up in their progress through a series of stations on a roller conveyor. From the assembly section the completed machines are transferred to a running-in and adjustment section where they also undergo final inspection.

At the time of the demonstration it was announced that the placing of the order for the 00G machines anticipated the laying down of a new works for building Brown and Sharpe machines in the Plymouth area. When the first section of this new works is completed the whole of the tooling and production equipment will be transferred from the Mollart works to the new factory. The Mollart Engineering Company, Ltd., will then tool up for the production of another batch of a different size of the American firm's automatics and this equipment will later be transferred to an extension at the Plymouth factory.

Lightweight Self-Excited Alternators

A lightweight alternator, with a rotating field system in which the excitation and voltage regulation are maintained by "Rectifex" voltage control, has been developed by the Brush Electrical Engineering Company, Ltd., Loughborough. In this system of control the field current is derived from the alternator terminals, through a transductor and a rectifier; voltage regulation is effected by a voltage detector and a magnetic amplifier which supplies the saturating winding of the transductor. The "Rectifex" system is at present applied to 100kW and 150kW alternators and a 250kW equipment is being developed.

LAST week we attended a demonstration by the Brush Electrical Engineering Company, Ltd., Loughborough, of the firm's lightweight self-excited, self-regulating alternators. Excitation and voltage regulation are provided by the "Rectifex" voltage control system which, as described below, is a static rectifier equipment. Two diesel-driven sets, with outputs of 100kW and 150kW respectively, were demonstrated, and a third alternator with an output of 250kW is under development.

The alternator (Fig. 1 illustrates the 150kW machine) is unusual in that the yoke carrying the field system is designed to be coupled directly to the flange end of the engine crankshaft and rotates around the outside of the armature which is stationary. The two main advantages of this form of construction are: first, that the rotational inertia of the yoke is sufficient to allow the conventional flywheel to be omitted, and that the stationary armature is of simpler construction and has a lower iron loss than the normal armature. Large inlet and outlet areas can be used for the cooling system and a large rotating mass is available to dissipate the heat. As can be seen from Fig. 4, the field coils are wire wound and bent to shape before impregnation and, being shaped to conform with the curvature of the yoke, the coils occupy the minimum radial depth and thereby limit the overall diameter of the yoke. The passages between the coils are narrow and the cooling air speed is correspondingly increased. Silicone insulation is used throughout and, at the rated output under normal ambient conditions, the hot-spot temperatures are stated to be sufficiently below 180 deg. Cent. (the safe temperature recommended by the International Electrotechnical Commission for this class of insulation) to ensure long life.

The arrangement of the 100kW alternator is generally similar except that in this machine the metal-rectifier equipment is mounted in the inlet air stream at the non-driven end of the machine, where it is protected by a sheet-metal end cover with screened air inlet (Fig. 3). In the 150kW and 250kW alternators the rectifiers are mounted in the separate "Rectifex" cubicle.

To illustrate the saving in weight the manufacturer draws the following comparison, based on a 100kW alternator coupled to a McLaren "LE6" engine of 150 b.h.p. at 1500 r.p.m.:—conventional alternator and overhung exciter, total weight 2450 lb, overall length 5ft; lightweight alternator 1200 lb, "Rectifex" control 300 lb, total 1500 lb, overall length 2ft 5½in.

The 250kW alternator (Figs. 4, 5, 6,) which is at present under development, differs from the two smaller machines in that it has a single bearing. The stator frame and armature assembly (Figs. 5 and 6) carries the bearing and sliprings, the shaft being hollow to carry the connections to the field coils. The rotating field system is shown in Fig. 4 before impregnation of the field windings.

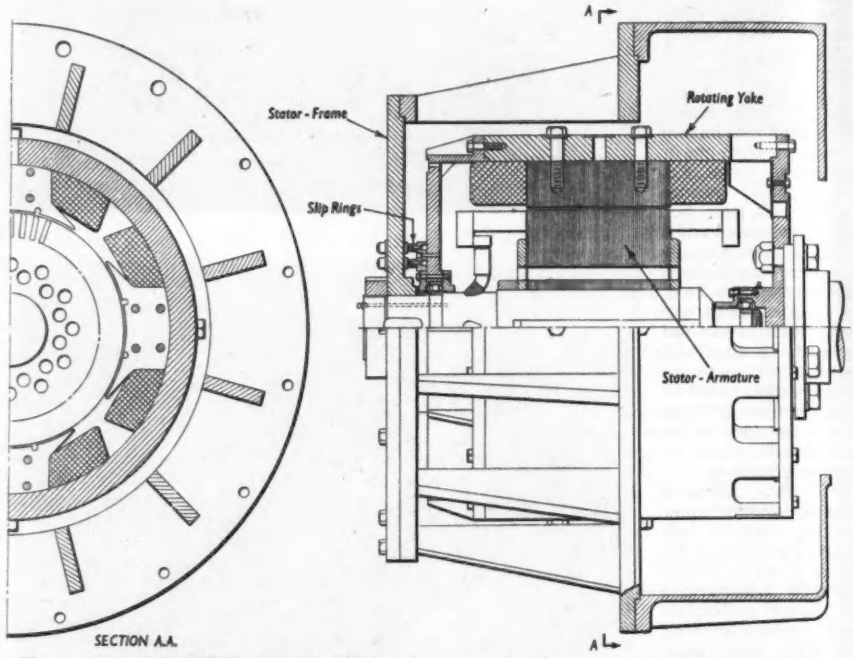


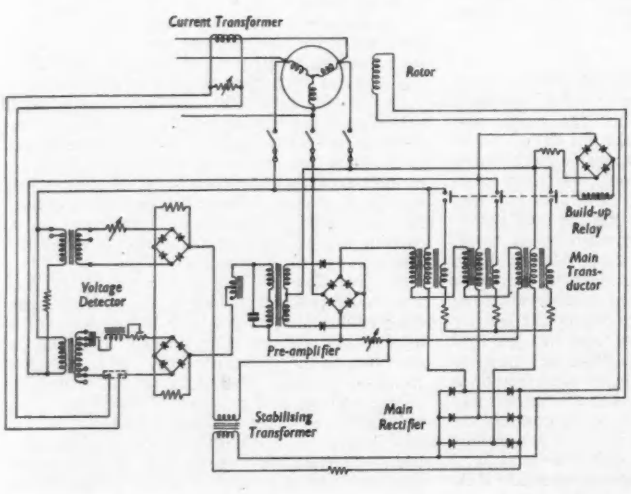
Fig. 1—Lightweight 150kW alternator with rotating yoke and self-excitation with "Rectifex" control

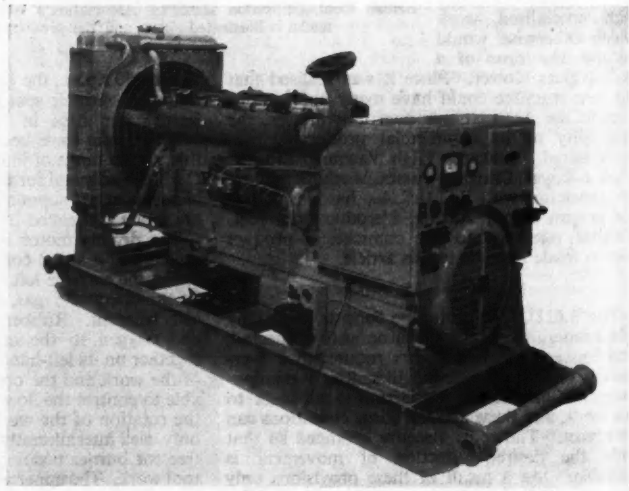
The "Rectifex" system of excitation and voltage control is an arrangement of transductors, magnetic amplifiers and rectifiers. It will be seen from the diagram reproduced in Fig. 2 that the main alternator field is supplied from a metal rectifier, the input side of which is connected across the alternator output terminals through a transductor. The saturating winding of this transductor is supplied by a magnetic amplifier whose input is taken from a voltage detector unit (of the kind fitted to "Amplidex" alternators*) which is also fed from the alternator terminals. Thus any variation in alternator terminal voltage is fed to the detector, amplified, then applied to the saturating winding of the transductor, thus varying its reactance and, in turn, the field current of the alternator.

Because of the relatively high forward resistance of the main rectifiers, it is necessary to boost the residual voltage of the alternator, to ensure that voltage build-up takes place on starting. This boost is done by providing an auxiliary winding on the main transductor, which converts it into a transformer. The auxiliary winding is energised by a starting (build-up) relay, and is cut out when the voltage reaches a value sufficient to ensure satisfactory build-up.

There are a number of refinements incorporated

* See THE ENGINEER, Jan. 22, 1954, page 144.





Figs. 2 and 3—(left) Circuit diagram of "Rectifex" controlled lightweight alternator. (Right) Diesel engine alternator set with "Rectifex" excitation and voltage control system, suitable for parallel running. Output at 50 c/s, 1500 r.p.m., 100kW; at 60 c/s, 1800 r.p.m., 110kW

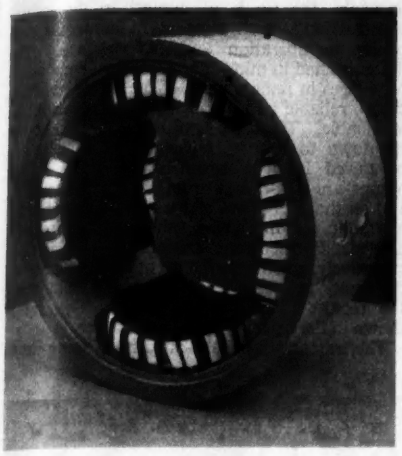


Fig. 4—Rotating yoke of lightweight, 250kW alternator under development

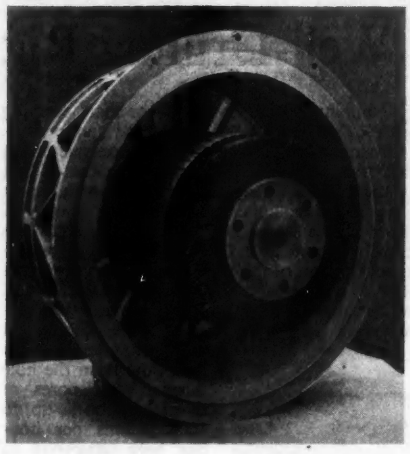


Fig. 5—Stator frame carrying armature of 250kW alternator

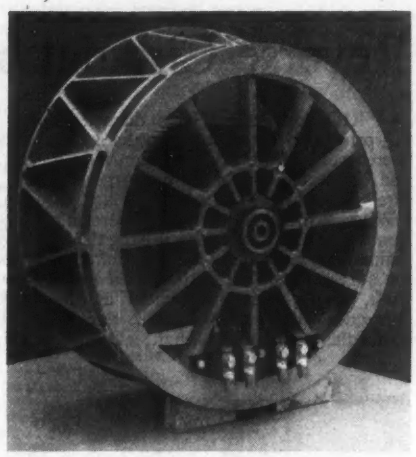


Fig. 6—Stator frame and armature of 250kW alternator, showing the sliprings and the armature terminals

in the "Rectifex" system to improve its performance. First, the voltage detector has a filter circuit to ensure that any variation of alternator wave-form due to loading does not cause errors. Secondly, the pre-amplifier has a very large amplification, achieved by current feedback and the use of high-grade core materials. Thirdly, a stabilising transformer is used between the output of the main transductor and the input of the pre-amplifier.

In the event of failure of any of the components other than the main rectifier, hand control can be arranged.

A nominal regulation of 2½ per cent is guaranteed, but the manufacturer states that a much closer regulation is inherently feasible because of the very large amplification of the system. Parallel running is possible with both similar and dissimilar sets, provided the latter have reasonably stable drooping voltage load characteristics. Generally, a 3 per cent voltage droop from no load to full load is required, but this can be improved upon in many cases.

The performance of a single-running set at various loads was demonstrated on a Petter-McLaren "LE6" engine coupled to a 100kW lightweight alternator with "Rectifex" control. The "LE6" engine is designed to develop 150 b.h.p. at 1500 r.p.m. for an output of 100kW at 50 c/s and 180 b.h.p. at 1800 r.p.m. for an output of 110kW at 60 c/s.

This set was used for tests at 50 c/s and 60 c/s. In each case the speed of the set was first adjusted at no load and then the effect of various changes in load was demonstrated by measuring the voltage and frequency at each load, the set being under "Rectifex" control throughout. The results are summarised in Tables I and II:

TABLE I—*Single Running*, 100*kW at* 50 *c/s*

Load, kW	Power factor	Frequency, c/s	Voltage, V
No load	—	52	420
53	0·82	51	418
74	0·74	50·5	417
94	0·76	50	416
No load	—	52	418

TABLE II—*Single Running*, 100*kW at* 60 *c/s*

Load, kW	Power factor	Frequency, c/s	Voltage, V
No load	—	61	420
30	0·8	61	420
76	0·84	60·3	419
99	0·79	59·5	418
80	0·66	60·5	418
37	0·47	61·0	418
3	0·1	61·0	420

Load sharing between sets running in parallel was demonstrated with three sets: the 100kW set described above; a 150kW set, consisting of a National "M4AA6" engine developing 240 b.h.p. at 1500 r.p.m., driving a lightweight alternator of 150kW at 50 c/s; and a 27·5kW set, consisting of a Petter McLaren "PDV6" air-cooled engine developing 60 b.h.p. at 1500 r.p.m. and 72 b.h.p. at 1800 r.p.m., coupled to a 27·5kW generator with "Amplidex" control. The two larger sets were equipped with "Rectifex" control.

For this demonstration kVAR-sharing was effected by the astatic method, using differential compensating transformers. This method was preferred to the static method, using a quadrature droop transformer on each alternator, because of the improved voltage regulation.

TABLE III—*Astatic Parallel Running*

Line voltage	Total kVAR, percentage F.L.	Load sharing as percentage of full load		
		27·5kW set	100kW set	150kW set
419	88·4	95	87	87
421	69·8	81	70	66
421	52·8	70	53·5	48
422	36·4	49	35	34

The results of the test are summarised in Table III.

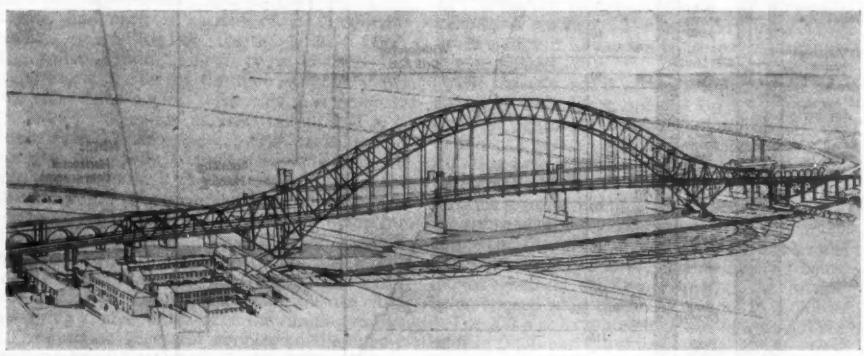
Runcorn-Widnes Road Bridge

It has been announced that a contract has been let for the construction of a steel arch bridge over the River Mersey, to replace the Runcorn-Widnes transporter bridge; work is to start immediately, the Ministry of Transport and Civil Aviation states, and it is hoped that the bridge will be finished in 1959.

The bridge and approaches, extending for nearly four-fifths of a mile, will terminate at two roundabouts at Greenway Road, Runcorn, and Irwell Street, Widnes. The bridge will be 1632ft long and will incorporate a main span of 1082ft and two 275ft trusses, extending landwards from the main skewback piers, which form the foundation of the main arch. The approach viaducts which will be constructed on piers, with short spans varying from 70ft to 90ft, are 1425ft long on the Runcorn bank and 780ft long on the Widnes approach. The bridge will incorporate a 33ft carriageway and a 6ft footpath. An idea of the completed structure is given by the illustration below.

This site is of particular interest because a suspension bridge was first proposed, but a new problem was encountered—aerodynamic buffeting due to the proximity of the existing railway bridge. The problem was described in our issue of July 30, 1954, and a detailed account of the experiments on buffeting carried out at the National Physical Laboratory was published in our issue of May 13th last.* The extra measures necessary to resist the wind loads due to buffeting made the suspension design less attractive, and hence the steel arch bridge was designed.

The consulting engineers for the bridge are Messrs. Mott, Hay and Anderson and the main contractor is Leonard Fairclough, Ltd. The estimated cost of the bridge is £2,063,000, and the Minister of Transport and Civil Aviation has informed the Runcorn-Widnes Bridge Joint Committee that he is prepared to make a grant of 75 per cent of this amount.



Impression of the proposed steel arch bridge with a main span of 1082ft, to be built over the River Mersey

Symposium on the Plastic Theory of Structures

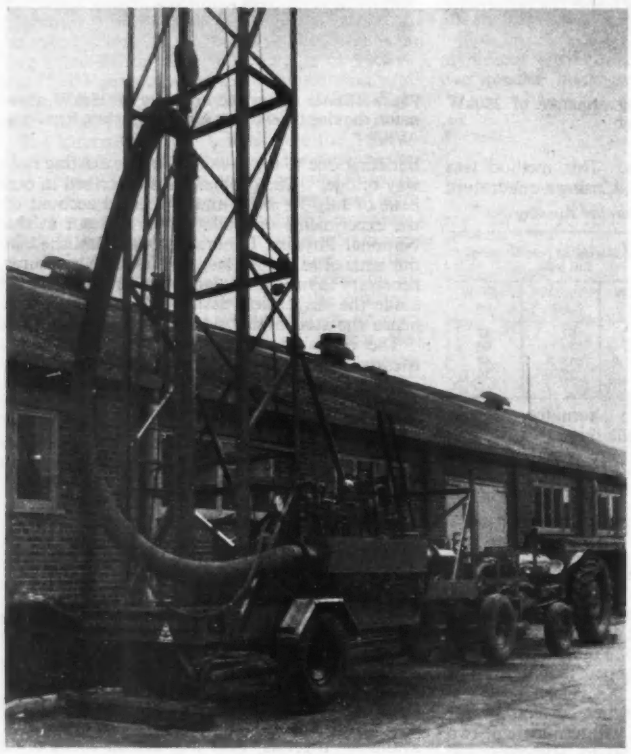
Cambridge University is holding a symposium on the plastic theory of structures at Clare College between September 18th and 21st next. It is pointed out that progress in the development of the plastic theory has reached a stage where a new branch of the theory of structures of considerable educational value is available, together with a practical method of design of wide application. It therefore appeared to the research team at Cambridge that the time was opportune for a discussion of the work by teachers and practising engineers. The plastic design of steel structures is now finding increasing application—recent practical examples described in these columns include the large two-storey shed and terminal at Southampton—and has been incorporated in British Standards for steel design. The first notable application of the method was in the design of the Morrison shelter during the war. The provisional programme of the symposium includes eight working sessions, devoted largely to informal discussion.

* "Aerodynamic Buffeting of Bridges," by C. Scruton.

Reverse-Circulation Well-Drilling Rig

A RIG for drilling large diameter holes—principally as wells for water supply—has been developed by Niels Matheson and Co., Ltd., and is being marketed by Argelane, Ltd., Gralane House, 16, Catherine Place, London, S.W.1. A principle known as "reverse circulation" is utilised to assist in drilling the hole and maintaining its stability until the lining materials are added. The drill bit is carried by a hollow shaft, which is slowly rotated as the work proceeds. Water flows into the annular space round the outside of the shaft, and is extracted, by pumping, up the interior of the shaft, carrying with it the solid materials displaced by the bit.

By introducing water round the outside of the drill pipe a hydrostatic pressure in excess of that of the natural water table is maintained against the walls of the hole. The downward velocity of flow of this water is relatively low, since the cross sectional area of the drill pipe is only a small fraction of the total area. It is considered that an additional head of 6ft, over the natural water table, is needed to ensure stability of the hole. A further effect promotes stability in sand formations, namely, a flow from the hole through the pores of the formation; up to 1000 gallons per hour has been absorbed in this way in drilling through sands.

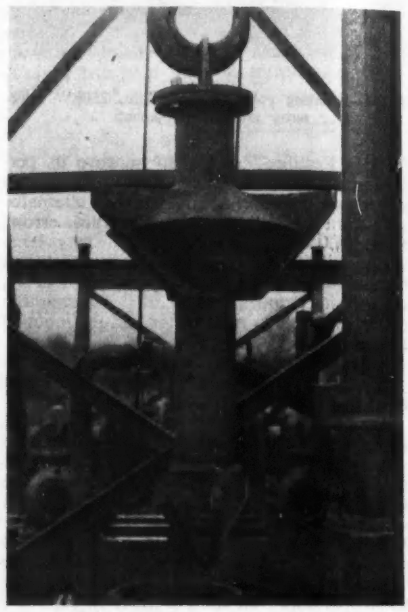


Rig erected for drilling. Note the controls grouped to the right of the mast, with the cooling box for hydraulic fluid below them. The tractor-driven hydraulic pumps can also be seen

Much improved performance over alternative drilling methods, particularly in soft formations, is claimed for reverse circulation drilling; holes up to 6ft in diameter are practical, the larger diameters enhancing the yield of water in many cases. The rig is also considered to have promising applications in dewatering constructional sites, and in drilling holes for large diameter cast-in-situ piles of high carrying capacity. A demonstration with the rig mentioned above, which is known as the "30–50 Hydro Rig," was given recently at Dorking, where a 2ft 6in diameter hole, 119ft deep, was sunk through the Greensand for local water supply. Some typical progress figures are shown in the accompanying diagram, in which actual working times are plotted in the progress chart.

Apart from its use of the reverse circulation principle, the rig is of interest in its general construction, which aims at fundamental simplicity in operation and maintenance. The designers had in mind the water supply problems of villages in remote parts of the world, where a cheap, reliable and mobile drilling rig would be invaluable. Thus, the first aim was to keep the rig down to 5 tons in weight, so that it can be towed by a Fordson tractor. Hydraulic pumps are belt-driven from the tractor engine, and all the operations of the rig are powered by hydraulic motors, so no other prime mover is needed. Furthermore, unit construction is used extensively, so that in the event of a breakdown the faulty unit can be replaced, thus obviating site repairs to major assemblies. The rig is shown in the accompanying illustration.

The tractor power take-off drives three pumps



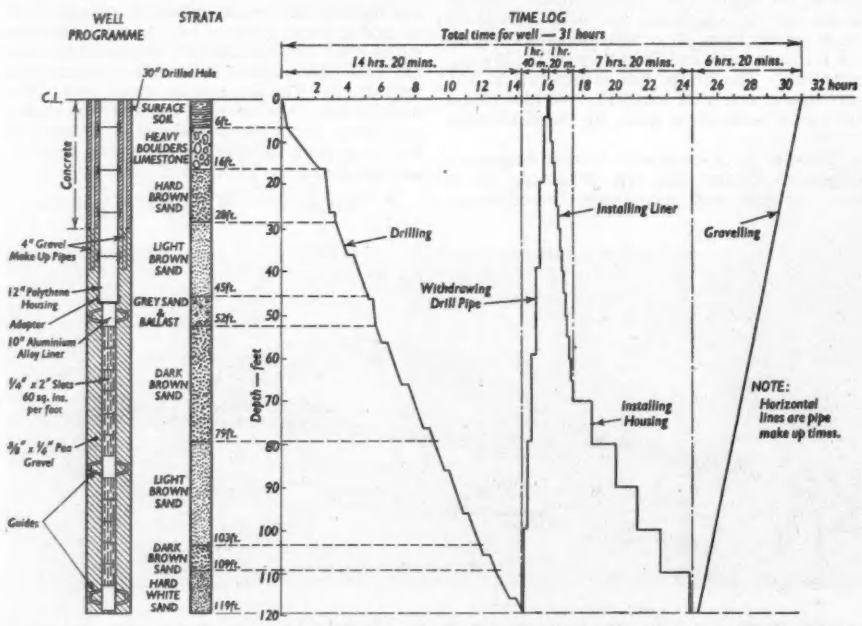
Composite drilling bit for penetrating hard formations

—two of 25 g.p.m. and one of 5 g.p.m.—and one hydraulic motor is powered by each pump. One of the larger motors drives the centrifugal pump which extracts water and solid materials from the hole. The second powers the rotary table, and hence the drill bit, and alternatively the hoists. The smaller motor powers the two jacks used for erecting the mast and also movement of the crown and travelling blocks. The hydraulic fluid itself lubricates the motors and is cooled by the circulating water.

The 40 h.p. available from the tractor engine is transmitted through the hydraulic pumps at a maximum pressure of 2000 lb per square inch, but in fact the relief valves are set to limit this pressure to 1500 lb per square inch.

At the Dorking site, the average hydraulic pressure required to rotate the table was 300 lb per square inch. The rotary table has three speeds, 8 r.p.m., 15 r.p.m. and 30 r.p.m. The suction pump which has obtained up to 27in of vacuum whilst delivering approximately 60,000 gallons per hour of debris-laden water, absorbed a hydraulic pressure of 1000 lb per square inch. The hoist motors were absorbing a maximum of 1000 lb per square inch, and whilst upon test with a load of 7½ tons in the derrick, were operating at 1500 lb per square inch. The mast rams lifted the mast at 600 lb per square inch. Reflux valves are fitted to the mast ram to control the speed of lowering the mast.

When the rig is in use, 10ft lengths of drill pipe are successively introduced as the hole proceeds (they have machined flanges and are bolted together) and the kelley is bolted above the topmost one. The kelley is square in cross-section and fits through a square hole in the rotating table, thus transmitting the drive. The table is of oil-bath construction and is driven through reduction gearing. There are separate crown and travelling blocks to handle the



Working times and bore data for demonstration well sunk by reverse circulation rig near Dorking, Surrey

kelley and a length of drill pipe, with hydraulically-operated traversing movements so that either can hang over the hole.

A new development is a quick-acting screwed coupling for the lengths of drill pipe. It has been found that about 30 per cent of drilling time (the " steps " in the time chart) can be taken up by joining on the bolted sections ; furthermore, leakage can take place with the bolted joint, thus lowering the drilling efficiency.

Our last illustration shows a drilling bit intended for penetrating hard formations, such as marls, hard sandstone and ironstone. A collar is attached behind the bit to give the required penetrating weight, and cutting is in two stages, the pilot cutters penetrating the strata and the reaming cutters trimming the hole to size. Due to the shroud on the reaming cutters, an eroding effect is produced by the down-flowing water as it passes round the collar. For soft formations a simpler bit is used.

The life of a tube well can generally be said to be the life of the liner and housing pipe. These deteriorate : (*a*) through corrosion, generally accelerated by anodic discharge, and (*b*) incrustation of the slots. For this reason a light-weight, non-corrodible liner having thin walls and being joined by a provisionally patented system of dimpling has been used, and this has been hung from the surface, as shown in the cross-sectional diagram, on a housing pipe extruded from polythene, having screwed connections.

400 h.p. Diesel-Electric Shunting Locomotive

A DIESEL-ELECTRIC shunting locomotive for heavy industrial use, of new design, which has been developed by the Yorkshire Engine Company, Ltd., Sheffield, is now being made in two models, one of 200 h.p. and the other of 400 h.p. These locomotives are fitted with Rolls-Royce diesel engines and B.T.H. transmission equipment, and they are complementary to each other, in that the power equipment of the larger model duplicates that of the 200 h.p. locomotive. The 400 h.p. locomotive, to be seen in the illustration on this page, was recently demonstrated at the Scunthorpe works of the Appleby-Frodingham Steel Company, where it hauled on typical industrial gradients and curves trains of ore wagons, ingot cars and slag ladle cars. This 0-6-0 locomotive can be built for any gauge from metre to 5ft 6in, and with reduction gearing suitable for specified railway or industrial shunting requirements.

The larger locomotive has a weight of 48 tons and a wheelbase of 11ft. It has a starting tractive effort of 30,000 lb, and at the continuous rating speed of 8 m.p.h. has a tractive effort of 13,100 lb. The maximum permissible speed is 23 m.p.h. The two sets of power equipment are arranged one on each side of a central driver's cab, and they are linked to one set of controls for multiple working. In the event of one of the power sets breaking down, or for light duty working, the locomotive can be worked effectively on the other set.

The locomotive has a rigid steel plate frame with heavy buffer beams at each end, and fabricated steel stretchers between the frames form a continuous deck for the power equipment. A transverse bridge across the frame carries the air reservoirs and other brake equipment, and forms a platform on which the cab is mounted. Four fuel tanks, which are fitted between this transverse bridge and the buffer beams, provide side platforms for the locomotive. Cast steel axlebox guides bolted into the frames are fitted with manganese steel liners. Roller bearing axleboxes can be provided, if required, but the standard axleboxes fitted have renewable leaded phosphor-bronze bearings and collar liners. Laminated bearing springs rest on the axleboxes and are fitted with adjustable sword hangers. The solid forged axles have pressed-on and keyed cast steel wheel centres with shrunk-on tyres.

Each of the power units consists of a six-cylinder, four-stroke, supercharged Rolls-Royce C6-SFL oil engine, directly coupled to a B.T.H. single-bearing, six-pole, commutating-pole, traction generator. These units, one of which can be seen in an accompanying illustration, have the radiators connected to the front of the engine, and each is carried on a three-point resilient suspension on the locomotive deck. The radiator pump, auxiliary generators and compressors are driven through vee belts at the free end of the engine. The engine is designed to develop 200 b.h.p. at 1800 r.p.m., and it is fitted with a lubricating oil heat exchanger to bring the oil rapidly to efficient working temperature and maintain it at that temperature under all conditions. The fuel injection pump assembly on the side of the engine includes a lift pump for supplying fuel from the main tank to the injection pump through paper element filters. A mechanical compensated speed control governor forms part of the injection pump unit and ensures close governing at all speeds within the running range.

The traction generator coupled to the engine has a continuous rating of 124kW, 500V, 248A at 1800 r.p.m. and 113kW, 378V, 300A at 1600 r.p.m. It supplies current to a four-pole, commutating-pole, traction motor, which is spigot mounted on an axle-hung gearbox. This motor has a continuous rating of 143 s.h.p. at 440V, 270A and 1330 r.p.m. The fabricated steel gearbox is split on the axis of the road axle, on which it is carried by split, oil lubricated sleeve bearings. In this gearbox the lay shaft, which carries a spiral bevel wheel and spur pinion, is mounted in anti-friction, cartridge-mounted bearings. By external adjustment of these cartridge-mounted bearings the gears can be thrown out of mesh so that the locomotive can be towed safely at speeds in excess of the permitted maximum.

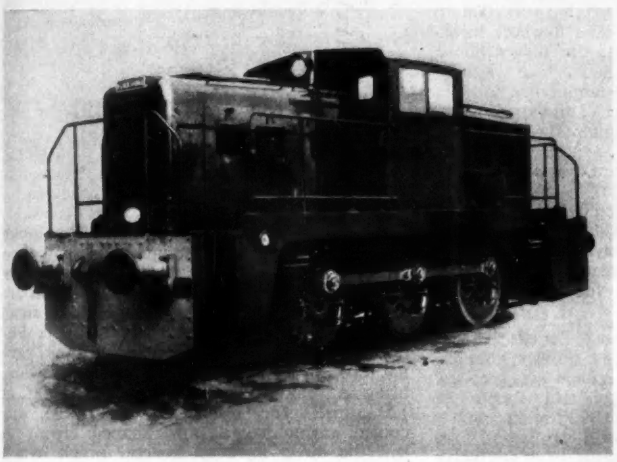
In the control system locomotive power is varied by variation of engine speed so that, once the traction contactors have closed, no further change takes place, and the movement of a cam-operated controller lever serves to increase the speed of the diesel engines by altering the setting of the governors. Traction motor field shunting takes place at a predetermined generator voltage under control of a field shunting relay.

The control system is based upon a self-excited shunt-wound generator coupled to the diesel engine. The series-wound motors are connected by contactors through reversers to the main generators, which are designed with steeply drooping characteristics. A light separate shunt field is provided to give a fixed short-circuit current. This short-circuit current is chosen to correspond to a suitable " stall " tractive effort of the motor and thus is self-protecting. The generators also have a series winding so that the engine may be started by motoring the main generator from the battery.

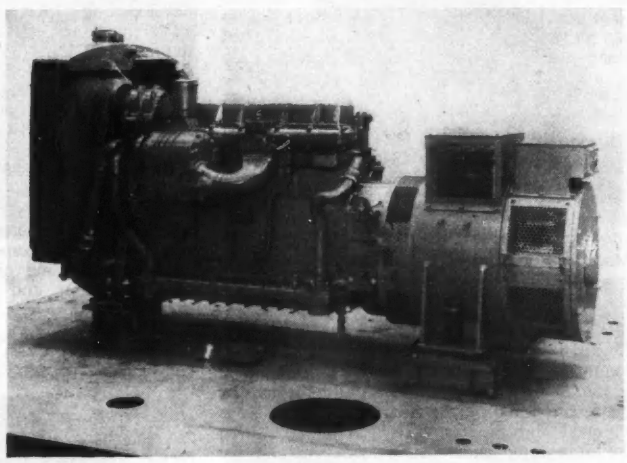
The maximum output of the diesel engines is determined by fixed stops on the fuel injection pump control racks. As the generator increases its loading upon the engines fuel is increased by the governors until this maximum is reached, after which further loading on the engines will cause a reduction in engine speed. This reduction in speed, however, rapidly reduces generator voltage and hence the loading upon the engines until a balance is reached. The reduction in speed is never sufficient to cause serious loss of available engine power.

The driver's cab is of welded steel plate construction with doors opening on to diagonally opposite platforms. Large windows on all sides of this cab give a clear unobstructed view of all shunting operations. The control desk is set in the centre of the cab with the handles for the throttle, reverser and brake duplicated so that they are conveniently to hand from any position in the cab. The throttle and reverser levers are mechanically interlocked to prevent the reverser being moved when the throttle is open, or the throttle being opened when the reverser is not in position.

The 200 h.p. locomotives of the new design are built in 0-6-0 and 0-4-0 types weighing 30 tons. They have a maximum tractive effort of 18,000 lb and a continuous tractive effort of 7400 lb at 7 m.p.h.



400 h.p. diesel-electric shunting locomotive with a starting tractive effort of 30,000 lb and a continuous tractive effort of 13,000 lb



One of the two 200 h.p. diesel-electric power equipments of the 400 h.p. shunting locomotive

Machined Aerofoil Surfaces

A PROLONGED study of the problems involved in producing metal panels of aerofoil shape with integral stiffeners, carried out in conjunction with several machine tool manufacturers and such firms as Boulton Paul Aircraft, Ltd., whose milled wing was described on page 806 of our issue of December 2, 1955, has led the Ministry of Supply to order a prototype machine from J. L. Jameson, Ltd. This tool is required to reach the final aerofoil contour so closely as to call for no more than a final polishing operation, and, in the case of the Jameson design, is also able to machine the integral stiffeners on the inner surface. The outer surface is cut in the manner of a shaping machine by a single cutter moving in a straight line, and the greatest interest lies in the means used to establish that this line shall be a generator of the surface required.

The slab of material, which for purposes of describing directions will be assumed to be the upper surface of a wing, is clamped to a vertical table, the line of flight—i.e. maximum curvature—being generally vertical. This table can swing through the horizontal plane and move along the yaw axis of the wing. Facing the upper surface of the slab is the beam along which the cutter head moves. This beam can rise and fall along the flight path, and in action is fed in this

Model of a wing panel, as machined with a V-point tool

direction between each cut. The slab is advanced towards the cutter, and at each end of it is mounted a cam which determines the final profile; when these cams are intercepted by probes mounted on the cutter beam the table is clamped and the cut taken. The table then withdraws, the cutter beam feeds on, and the cycle is repeated automatically. If the panel is not of constant curvature, the angle of the beam in the yawing plane must be altered as it rises and falls, and a link mechanism is provided which gives a constant proportionality between the advance at the two ends. For a tapered wing the two cams will, of course, be of different sizes, and the generation will be straightforward. Where washout is required the cams can readily be set at different angles of incidence, but this will normally result in a loss of accuracy of generation. Clearly, instead of the actual chord, its projection in the plane of the table will be defined. In the case of a section composed of a circular arc, a perfect profile could be obtained with cams extending beyond the actual workpiece, the generators running at a skew angle to the span.

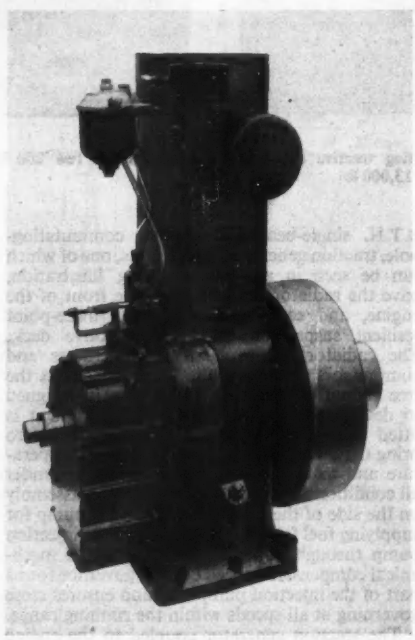
The machine can, with equal accuracy, generate a female of the wing, and this can be used as a vacuum chuck to support the slab for the machining of the inner surface. A milling head can be used in place of the cutter to sink recesses, leaving stiffeners running chordwise as well as along the generators.

This technique of generating aerofoil surfaces was evolved from that used by the firm for shaping turbine blades, but the prototype machine will have a work table 24ft by 8ft. It is expected to be completed in approximately twelve months, and will be used to make sample wings to demonstrate the technique to aircraft manufacturers. The light alloy slabs will be solution treated and stretch levelled before machining, precipitation treatment following. It is hoped that the Northern Aluminium Company, Ltd., will be able to taper and roughly curve the blanks so as to minimise the metal removal. The illustration shows a model made on the principles described, having a taper of approximately ¼in in its length of about 6in, with the material thickness also tapering, and a twist of 13 deg. 11 min. The photograph is Crown copyright, reproduced by permission of the Controller, H.M. Stationery Office.

Three Low Power Diesel Engines

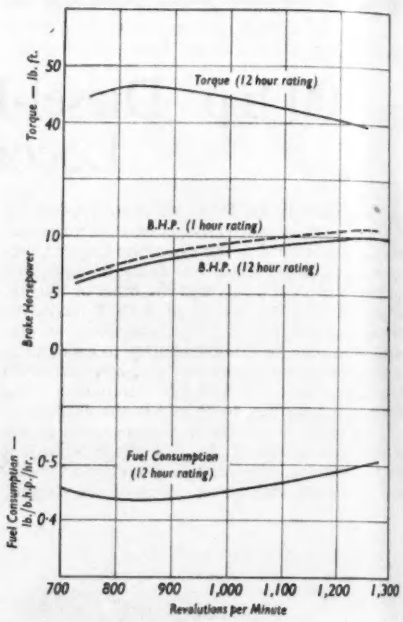
THREE models of single cylinder diesel engines have recently been reintroduced by Capel and Company, Ltd., Harrison Works, Halstead, Essex, and have been evolved from the designs of the well tried engines previously built by the company. In its early years the company, which was established in 1890 and had its workshops at Dalston, London, manufactured gas engines, gas producer plant, vertical and horizontal petrol/parafin engines, and, in association with Mr. T. Clarkson, produced steam cars and buses.

The engines currently in production are the Mark DA2, DAA2, and DB2 units all of which are vertical, four stroke, totally enclosed, cold starting engines of simple and robust construction. There are a minimum number of working parts and starting is by hand. Mark DA2 engine is arranged for tank or radiator cooling, while the DAA2 unit is air cooled; otherwise both engines have similar particulars. The bore and stroke are each 3½in (89mm) and the power developed is 3·5 h.p. to 4·5 h.p. at 1000 to 1250 r.p.m. respectively. The flywheel has a diameter of 15in (381mm); the pulley has a diameter of 6in (152mm) and a face width of 6½in (165mm). A fuel consumption of 0·45 lb/b.h.p./hour is given for the DA2 unit and 0·47 lb/b.h.p./hour for the DAA2 engine. The DB2 engine is rated to develop 7·5, 8·5 and 10 b.h.p. at 850, 1000 and 1250 r.p.m. respectively, and has a bore of 4½in (114mm) by 5½in (140mm) stroke. The flywheel diameter is 18in (457mm) and the pulley diameter and face are 8in (203mm) and 6½in (165mm) respectively. All three engines have a lubricating oil consumption of 0·003 pint/b.h.p./hour and have fuel tanks of two gallons capacity. The photograph which we reproduce illustrates a DB2 engine and the accompanying graph shows the performance curves.



Mk. DB-2 engine developing 10 b.h.p. at 1250 r.p.m.

Except in one or two particulars the engines are built to the same specification. Cast iron is used for the crankcase, which is of robust design and has a large removable free-end cover giving access to the lubricating oil pump and relief valve, governor and fuel pump drive. The cylinder block is of close grain cast iron and encloses the push rods, and similar material is used for the cylinder head which carries the rocker



Mk. DB-2 performance curves

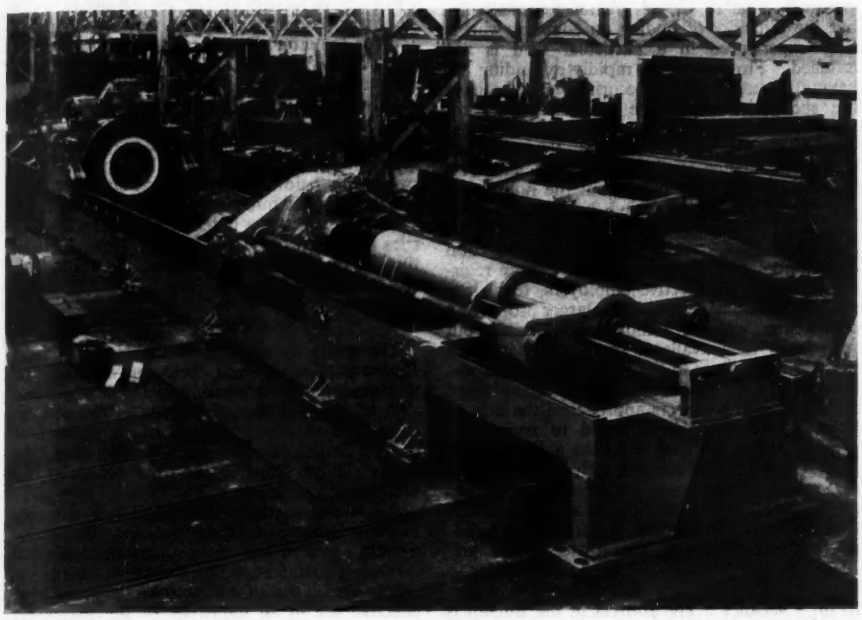
arms, decompressor gear, and valves. One inlet and one exhaust valve are fitted, and they are of nickel chrome steel and operate in renewable cast iron guides. The pistons are of aluminium alloy and have three compression and two scraper rings and a fully floating gudgeon pin. Cast steel connecting rods of "H" section are fitted and have a phosphor bronze bush small end bearing which is splash lubricated. For the DA2 and DB2 engines the pistons have flat tops, since these units have indirect injection, using a pintle pattern nozzle operating at 120 atms. The piston in the DAA2 air-cooled engine has a bowl shaped crown to suit the direct injection system, which uses a multi-hole nozzle and injects at 150 atms. All engines are equipped with C.A.V. pumps, injectors and paper element filters. The forged steel crankshaft is carried in large diameter thick walled main bearings of phosphor bronze while the big end bearing is white metal of thin wall design. The DB2 crankshaft meets Lloyd's requirements and is suitable for marine installations.

Mild steel is used for the camshaft, to which the cams are keyed. Lubrication of the engines is effected by a gear pattern pump, which draws oil from the sump through a gauze filter and delivers the oil by external piping to the main bearings and through the crankshaft to the big end bearing. A relief valve allows for pressure adjustment. Engine speed is controlled within the required limits by a centrifugal governor and all the performance figures are based on the use of gas oil having a calorific valve of not less than 19,00 B.Th.U.s. per pound, a viscosity not higher than 50 seconds Redwood at 100 deg. Fah., and a specific gravity of about 0·88. Completely portable units fitted on an underbed are available. With respect to the DA2, DAA2, and DB2 engines, the main particulars are:—overall height 32in, 36in, and 38in; width over crankshaft 24¼in, 24¼in and 26¾in; net weight 367 lb, 367 lb and 703 lb.

Untwisting and Stretching Machine

An untwisting stretching machine for extruded aluminium and light alloy sections, built by Joshua Bigwood and Son, Ltd., Wolverhampton, is illustrated on this page. This machine is designed to accommodate sections that may be enclosed within a circumscribing circle of 10in diameter, and 50ft in length, and provision is made for future extension of the bed for longer sections if necessary. The maximum pull exerted by the hydraulic ram is 100 tons, water at a pressure of 3600 lb per square inch being obtained from the shop mains supply. The machine has a stretching speed which is infinitely variable between 6in and 60in per minute, and enables the operator to select the speed most suitable for the section being stretched.

The fabricated steel bed, on which the two grip heads and the cylinder assembly are carried, consists of two heavy side frames braced together at intervals by cross members. The top faces



Untwisting and stretching machine for extruded aluminium and light alloy sections up to 50ft long

of the side frames, on which the grip heads move, are fitted with renewable wearing strips, and the anti-torsion guides on the side frames are also removable. The side frames are made in sections and coupled together with heavy connecting links to facilitate transport and erection on site. Anchor holes are provided in the side frames at short intervals along their length and in these holes the anchor pins of the adjustable head engage. These anchor holes are bushed with renewable, hardened and ground, steel liners, which are chromium-plated to lessen the risk of scoring of the pins or liners.

The adjustable grip head is moved along the bed by a 5 h.p. electric motor controlled by push-buttons. During the stretching operation the head is locked in position on the bed by the anchor pins which are operated by solenoid-controlled air cylinders. The anchor pins pass through two side plates on the head, which overhang each bed girder, and through the anchor holes in the girders. This form of construction enables the use of a relatively narrow bed and a locking means considered to be better than the conventional hook and rack system. It also gives an appreciable increase in the height of the pull line above the top of the bed to assist the loading and unloading of each bar.

The main cylinder has a long stroke of 5ft and is mounted on heavily braced cross members on the bed. As water is the working medium the main ram is treated to resist corrosion, and it is sealed by phosphor-bronze gland rings and special packing rings. The grip head is returned by a secondary ram which works in the main ram and is also actuated by mains water pressure. To prevent damage to the pipework should a section break while being stretched, a high-capacity relief valve is fitted to eliminate the excessive shock pressure in the return system which would otherwise occur upon breakage. A steel crosshead transmits the stretching load from the main ram to the grip head through two heavy steel drawbars. The weight of the main ram and crosshead is carried by rollers running on an extension of the main frame, and this form of support relieves the glands and sealing rings of the weight of the moving parts.

Similar grip mechanisms are fitted on each head and the special grip construction enables the machine to accommodate a wide range of sections. In the grips four opposing blocks work in inclined slides in the steel head, the grip blocks at the bottom and one side being manually adjustable by handwheel and screw gear. The opposing side and top grip blocks are operated by air cylinders. Serrated grip jaws which are attached to the grip blocks are flat-faced or shaped to suit the various sections. The gripping position is adjusted by the two manually adjusted grip blocks, final gripping being by the air-operated blocks.

The adjustable head, which travels along the bed, houses the rotatable member carrying the grip jaws; and the untwisting and adjusting motors and anchor pins are also built in this head. The main stretching and radial untwisting loads on the inner rotating member of the head are transferred to the housing by special radial and circumferential bearing rollers. While rectification of twist is not normally done under full stretching load, the drive to the untwisting grip housing from the 7½ h.p. motor is amply powerful to allow this. A circumferential scale calibrated in degrees, on the front of the head, indicates the degree of twist which has been applied to a section.

The adjustable head is gapped to allow a section to pass completely through it, so that the head may be traversed over the bar for removing twist which starts at a point in the run of the bar. This construction is stated to have an advantage over the hollow ram sometimes used, in that the section is not hidden from the operator's view in the long, hollow ram and grip head, and the ram and stretching grip head assembly is simpler and easier to maintain.

The electricity supply to the adjustable head is taken by flexible cables to spring reels on the head. Air from the mains is piped along the bed and, by means of quick action "Schrader" couplings fitted at intervals, a flexible hose from the head may be connected to the supply. The air supply to the rotating grip air cylinders is carried on a second spring reel on the adjustable head.

A push-button panel on the adjustable grip head is used for controlling the untwisting and travelling motors of the head, the anchor pin solenoid air valves, and the grip solenoid air valves. A red indicator lamp on this panel enables the operator situated at the stretching control valve, near the main ram, to see clearly that the anchor pins are engaged with the holes in the bed before applying stretching loads. A pressure gauge mounted near the main valve indicates the load applied during the stretching operation. This control system gives the operators complete control of all the motions, from positions where they have maximum visibility of the section in the machine.

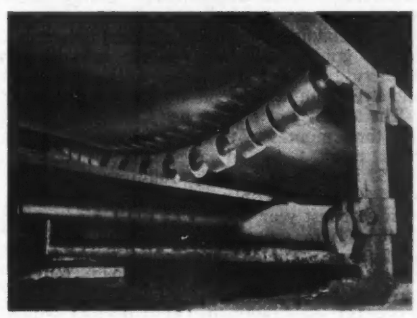
Flexible Conveyor Idler

A flexible belt conveyor idler which is designed to shape itself to the load being carried is now being made in this country by Joy-Sullivan, Ltd., Greenock. This idler is called the "Limberoller" and was developed by the Joy Manufacturing Company in the United States, where it has been used in a number of different industrial applications.

The idler, which is illustrated below, consists of a number of neoprene discs moulded to a neoprene-sheathed flexible steel cable. This cable is freely supported from two bracket-mounted, cadmium-plated, double-row ball bearings. The bearings are fitted with neoprene wiper seals at the open end and with dustcaps on their blind sides. They are charged with grease which has a temperature tolerance from −35 deg. Fah. to +275 deg. Fah., and are mounted a sufficient distance from the belt to avoid abrasive or moisture attack.

The neoprene discs have flat resilient support surfaces and, in addition to being tough and durable, resist attack from most chemicals except strong oxidising agents and aromatic hydrocarbons. The method of mounting the discs enables the idler to provide a full measure of support to the belt whilst conforming to irregularities in its loading. As the discs rotate the spacing between their upper and lower edges constantly varies, releasing any material which might be trapped between their faces.

Two forms of stands are made for use with the idlers. One stand is 13½in or 16in high and has a tripod base, and the other has brackets for mounting on conventional sections. Each form



Conveyor idler consisting of neoprene discs moulded on a flexible steel cable which is supported from and freely rotates in ball bearings. In this mounting a return idler is also fitted

of stand has standard mounting slots, into which the idler bearings are dropped and locked in place by spring clips.

With this design of idler no belts, cover sheets, or decking are required when conveyor sections are being made up, and their stands are linked by channel steel stiffening rails secured by mating lugs. These rails permit a slight lateral movement for lining up the conveyor belt when erecting the run.

Roller Straightening Machine.—A new design of 26in roller straightening machine for rolled steel sections and rails is now being made by Lamberton and Co., Ltd., Coatbridge, Scotland. The machine is designed to take up to 12in by 5in joists and 50 lb per yard rails, and has two banks of rolls at 26in horizontal centres.

Industrial and Labour Notes

Wages and Hours

As noted in our last issue, the national committee of the Amalgamated Engineering Union has been holding its annual conference at Eastbourne. Among the matters debated towards the end of last week, two of the most important were wages and working hours in the engineering industry. During recent years, it has become customary for the A.E.U. national committee to pass resolutions on wages which have subsequently led to claims being formulated by the Confederation of Shipbuilding and Engineering Unions, to which the A.E.U. is affiliated.

Last week's debate by the A.E.U. national committee resulted in the unanimous approval of a resolution calling for a substantial wage increase. Again, following last year's procedure, no specific amount was mentioned in the resolution, although it has been suggested that the delegates at the conference had in mind something like £1 a week. This latest demand, therefore, has been initiated about two months after the last wage settlement in the engineering industry. On February 28th, increases were announced of 12s. 6d., 11s. and 9s. 6d. a week for skilled, semi-skilled and unskilled men respectively. Last Friday, the Engineering and Allied Employers' National Federation commented on the resolution. Following a normal monthly meeting of its management board, the Federation said that the A.E.U. decision to seek a new increase in wages was contrary to national policy which was directed against the dangers of further inflation.

On Thursday of last week, the A.E.U. national committee discussed working hours. It expressed its support of the policy, already announced by the Confederation of Shipbuilding and Engineering Unions, for a forty-hour working week without reduction of wages. Reference was also made during the debate on working hours to the " dangers of excessive overtime."

Changes in Wage Rates

Statistics which have been published in the *Ministry of Labour Gazette* show that during March changes in wage rates in the United Kingdom resulted in an aggregate increase of about £2,407,000 in the weekly full-time wages of 4,546,000 workpeople, and in a decrease of £5000 for 179,000 workpeople. Among those receiving increases were workers in the engineering, shipbuilding and vehicle building industries, certain grades of workers in the coal-mining industry, dock labourers, and workers in iron and steel manufacture and in the gas industry.

The Ministry of Labour has stated that in the first three months of this year, changes in wage rates resulted in an aggregate increase of £3,852,300 in the weekly full-time wages of 8,594,500 workpeople. In the comparable period of last year, there was a net increase of £2,469,000 in the weekly wages of 7,718,000 workpeople. The changes in wage rates during March moved the index (June 30, 1947=100) up three points for all workers. At the end of March it was 161 compared with 154 at the end of last year.

Industrial Disputes

During March, there were 280 stoppages of work, arising from industrial disputes, which were reported to the Ministry of Labour. In addition, there were nineteen stoppages still in progress which had begun prior to the month of March. These included the stoppage in the London printing industry, and also the strike of joiners at Cammell Laird's shipbuilding yard at Birkenhead.

Taking the 299 stoppages which were in progress during March, the Ministry of Labour says that about 52,200 workers were involved directly and indirectly, and that 384,000 working days were lost. In the preceding month, in 277 stoppages of work through disputes, 97,800 workers were involved, the aggregate number of working days lost being 189,000.

In the first three months of this year there were 729 stoppages of work through disputes in progress. They involved 168,000 workers and caused an aggregate loss of 656,000 working days. In the comparable period of last year, there were 596 stoppages, involving 140,300 workers and resulting in a loss of 389,000 working days.

Professional Engineers' Appointments Bureau

In its report for 1955, the Professional Engineers' Appointments Bureau emphasises the continued shortage of civil, mechanical and electrical engineers. It says that there is no indication that the number of engineers seeking appointments, either at home or overseas, is adequate in any field to fill current vacancies. There are a good many changes by engineers from one appointment to another, either for personal reasons or to gain wider experience, and these changes are of value to employers generally if the engineers concerned are progressively able to accept greater responsibility, but the difficulty of finding an engineer who is fully experienced in a particular field is not lessened. Firms who are rapidly expanding are having great difficulty in securing staff who have the specialised experience which their vacant posts require.

In 1955, the report continues, there was no significant change in the numbers of engineers registering with the Bureau, but the number of vacancies notified increased by 20 per cent. The total placings rose by 15 per cent above the figures for 1954, but the more rigid specification of requirements laid down both by those registered and by prospective employers, tended to reduce the field of selection. A larger proportion of placings was for senior appointments, but with fewer men available for junior posts, the number of placings in the low salary ranges was reduced. The registrar says that many more employers and engineers approached the Bureau to discuss their problems, and to review the general employment market. At a time of full employment like the present, such contacts are of real value to employer, employee and Bureau alike. The facilities of the Bureau are available to any corporate member, graduate or student of the Institutions of Civil, Mechanical and Electrical Engineers who is contemplating a change of post, and to any employer who wishes to fill a vacancy. The address of the Bureau is 9, Victoria Street, London, S.W.1.

Capital and Labour

The chairman of the Rugby Portland Cement Company, Ltd., Mr. Halford Reddish, has prepared a statement which accompanies the annual report. In it, he comments on the distributed profits tax and " to the entirely false idea from which no government seems to have the moral courage to dissociate itself—that dividends have any relation to wages." Even the White Paper on the economic implications of full employment, Mr. Reddish says, went so far as to suggest that the effect of increased dividends was to generate pressure for what are felt to be corresponding adjustments of wages and salaries. Mr. Reddish's view is that this arises from a complete misconception as to the real nature of our modern industrial organisation.

The statement goes on to refer to a partnership between capital and labour. In theory, Mr. Reddish says, the two partners could enter into an enterprise that they would share the profits in agreed proportions at the end of the year. But, he observes, in practice this would not work ; first, because the labour of to-day has to be remunerated at comparatively short intervals in order to live, and, secondly, because all ventures are not successful, a fact, Mr. Reddish suggests, which some people are apt to forget. So, the statement goes on, we get what is in effect a bargain. Labour is guaranteed payment for its services whether the enterprise yields profit or loss, and capital takes the whole risk and receives as its reward such profit as may emerge. This difference in the basis of their respective remuneration, Mr. Reddish claims, in no way destroys the conception of industrial enterprise as essentially a partnership between labour and capital. Nor is it destroyed, he says, if this element of partnership, this unity of interest, is emphasised by a profit-sharing bonus in which all full-time employees participate.

But, Mr. Reddish adds, labour has no inherent claim on profit. Labour's claim is on the gross revenue of a business long before profit or loss can be ascertained and irrespective of either. Profits, the statement points out, are the reward of capital for having taken a risk which has turned out successfully, and they belong without question to the shareholders who have provided that capital. That is so, Mr. Reddish emphasises, whether the profits are distributed in dividend or not.

Industrial Production

The Treasury says that the index number of industrial production (1948=100) has been provisionally estimated at 142 for all industries in February, compared with a revised figure of 140 for January. The corresponding figures for last year were 140 for February and 135 for January. Taking the figures for the manufacturing industries only, the index for February this year has been put at 146, or one point higher than a year earlier ; for mining and quarrying the index number for February is given as 115, or two points below the figure for February, 1955. On the basis of information so far received, the Treasury expects the index number for all industries in March to be 140–141. In March, 1955, the index was 143, but the month did not include any part of the Easter holiday, as it did this year.

Efficient Use of Manpower

The quarterly meeting of the National Joint Advisory Council was held in London, on Wednesday of last week, under the chairmanship of the Minister of Labour. The council, it will be recalled, consists of representatives of the British Employers' Confederation, the Trades Union Congress, and the boards of the nationalised industries.

A statement which was circulated after the meeting indicates that the principal item on the agenda was a review of the efficient use of manpower. The statement says that there was general agreement on the importance of making the most effective use in all industries of the manpower available and of increasing productive efficiency. The council recognised that this object is the constant concern of those engaged in industry, though it was thought that a great deal of benefit might be gained from taking stock of the situation. At the same time it was agreed that this was not a matter which could be usefully dealt with in broad general terms, but was rather one which each individual industry should tackle in the light of its own special needs and circumstances.

The council therefore resolved that its joint consultative committee should consider how employers and trade unions should have their attention drawn to the need for a new and positive examination of practices which impede the full and efficient use of manpower resources. It was envisaged that these approaches would lead to joint consideration of the problem by the negotiating bodies in the industries concerned.

Coal Imports

A question addressed to the Minister of Fuel and Power last Monday asked how much coal was imported into this country between 1947 and 1955 inclusive, and how much of the National Coal Board's accumulated loss of £37,000,000 at the end of last year could be attributed to losses on the resale of imported coal. In a written answer, the Minister said that, in the period 1947–1955, 17,200,000 tons of coal were imported and supplied by the Board at an average cost of £2 8s. a ton more than the proceeds of resale. These extra costs, the reply added, were more than balanced by the premium obtained during the same period on exported coal. Thus, if the Board's overseas trading was considered as a whole it had reduced rather than increased the accumulated loss.

Indian Engineering News

BY OUR INDIAN CORRESPONDENT

Nandikonda Project

The foundation stone of the biggest dam in South India was laid by the Prime Minister of India, Mr. Jawaharlal Nehru, on December 10th, at Nalkonda, the site of the Nandikonda Project on the River Krishna. The project, which is expected to cost over Rs.130 crores (£100 million) will be undertaken in three stages, namely, (1) construction of the Nagarjuna Sagar dam to within 65ft of its ultimate height of about 400ft and the completion of most of the right bank canals ; (2) completion of the dam and the remaining canals, and (3) installation of the power system with a station of 75MW capacity and the transmission lines. The first stage, estimated to cost about Rs.75 crores, will take about seven years and the remaining stages will follow soon after. The project is mainly an irrigation project with annual benefits estimated at roughly 1·3 million tons of food grains. It is a joint venture of the Andhra and Hyderabad Governments and will be under the control of an autonomous board on the lines of similar boards managing the Damodar Valley, Bhakra and Hirakud projects. Under the recently announced reorganisation of states, the two states of Andhra and Hyderabad may be amalgamated into one big state of Visalandhra. Although the dam is actually in Hyderabad, the site being only about 10 miles from the frontier, all the canals will be in Andhra, some going as far down as Madras.

The dam will be about 400ft high, 15,000ft long, with about 1880ft of spillway, and will form a reservoir having a storage capacity of 9·3 million acre-feet, about 2,000,000 acre-feet more than that of the Bhakra reservoir. The dam itself will cost Rs.35 crores (about £27,000,000) and the canals, more than 300 miles long, will cost an additional Rs.95 crores. The South has always preferred masonry to concrete in the construction of dams, for reasons which are partly geological and partly sociological, stone and labour being about twice as cheap in the South as in the North, and cement not as freely available. Another point is that unlike most similar projects in the North, the Nandikonda scheme is essentially an irrigation one with power benefits almost negligible at 75MW, a large proportion of which is to be used mainly for lift irrigation.

Heavy Electrical Machinery

The Government of India has entered into an agreement with Associated Electrical Industries, Ltd., whereby the latter is to advise the Government on the establishment of a heavy electrical industry in India. Their appointment as consultants under the agreement is for a basic period of fifteen years. They will assist in the design, layout and construction of the factory or factories and advise on the general arrangements and procurement of the plant, machines and equipment. Designs for equipment will be supplied by them and they will help organise the engineering design department at the factory. The projected works for which a sum of about £20,000,000 has been kept aside in the next Five-year Plan, is expected to produce electric generators, transformers, switchgear and turbines for river valley projects and traction equipment for the railways. The detailed project report will be available within a year. A delegation consisting of representatives of the Ministry of Production and A.E.I. has toured the country with a view to selecting the site, and Bangalore in Mysore State has been mentioned as a likely locale. The plant itself is expected to go into production about five years from the preparation of the project report and will develop its full capacity over a period of seven years thereafter. The contract has been won by the A.E.I. in the face of strong competition from Western Germany and the U.S. and, although the firm will act only as technical adviser on the project, the contribution of U.K. manufacturers is expected to be substantial.

The project is expected to encroach on the activities of smaller electrical manufacturers at many points and has been criticised on that score. The Indian electrical manufacturing industry has been rather uncertain about its expansion plans for the last year or two since the idea of a state-sponsored plant was first mooted, and although assurances have been obtained as regards the supply of raw materials, &c., most of which are imported and scarce, many of the existing smaller plants have shelved their expansion projects. Most Indian manufacturers receive technical and, in some cases, financial and managerial assistance from foreign firms, notably British, and the question of expansion on a substantial scale is naturally tied up with the Government's economic policy. This policy, as it stands at present, has been criticised as not being very favourable to foreign capital.

Steel Expansion

An agreement for the construction of a 130 million dollar project for the expansion of the Tata steel plant at Jamshedpur has been signed between the Tata Iron and Steel Company and the Engineers Division of Henry J. Kaiser from the U.S. The project is calculated to raise the capacity of the plant from the present 1·3 million ingot tons to 2,000,000 ingot tons. The expansion will include a battery of twenty-six coke ovens, a new blast furnace 28ft in diameter, and a continuous sheet bar mill. Work is expected to start some time next year and the contract with Henry J. Kaiser stipulates the completion period as thirty months from December, 1955. The exact terms of the contract are not known, but it is believed that the American firm will act as consultant as well as erector and contractor of the plant. But the plant itself is to be purchased on the basis of global tenders and a team of Tata's engineers has already left for Japan and the U.S. " to obtain quotations for some major items required for the project." The time factor, however, is said to be crucial and because of the shortage in India of heavy construction machinery and equipment an order of £20,000,000 will have to be purchased from abroad. The question of finance has yet to be decided.

The project, incidentally, is in addition to the company's modernisation schemes, begun in 1952 and scheduled for completion in 1958. The schemes will add 300,000 ingot tons to the current capacity of about a million and involve considerable expansion and overhauling of the existing power and steam plant, the addition of a steel melting shop, a skelp mill, and a coke oven plant, besides a number of other smaller schemes in individual mills. On the steam and power side, the consultants are Associated Consulting Engineers (India), the Indian associates of Messrs. Kennedy and Donkin, of London, and the work has involved the installation of a 33kV circuit inside the works to receive the incoming supply from the Damodar Valley Grid at 132kV, three substations to step the power down to 6·6kV, and ancillary works such as pilot cables. Most of the suppliers and contractors were British, the transmission lines and towers being supplied and erected by B.I.C.C., 33kV switchgear by A.E.I. (India), 6·6kV switchgear by the South Wales Switchgear Company, Ltd., and the pilot cables by B.I.C.C. On the steam side, the work involves the construction of a new boiler-house with four 150,000 lb per hour capacity boilers at 250 lb per square inch and 650 deg. Fah. The boiler-house is to replace a twenty-five-year-old boiler plant. The new plant is being supplied by Babcock and Wilcox, Ltd., and erected by the company's Indian associates. This project is worth about £1·5 million and is scheduled for completion by the middle of this year. The boiler plant may later be expanded by the addition of two boilers, probably with back-pressure turbines if the scheme is approved by the authorities. (The Jamshedpur plant lies within the Damodar Valley Grid, whose authorities control both the public and the private power systems in the area.) The electrical side of this generating plant is being supplied by English Electric Company, Ltd.

Nuclear Power

The Geneva Conference on the Peaceful Uses of Atomic Energy presided over by an Indian, Dr. H. J. Bhabha, Chairman of the Indian Atomic Energy Commission, has made India, along with other Asian nations, atomic conscious. The first reactor will go into commission at Bombay some time this year. Another reactor has been offered to India by the Soviet Union and an American company has offered to install two reactors, one at Bombay and the other at Calcutta. The heavy water needed for the Bombay reactor has been obtained from the United States. The reactor itself was a present from the Canadian Government, which has undertaken to give an additional 3,000,000 dollars for its construction and the necessary technical assistance.

The Government of India has drawn up an ambitious scheme for developing nuclear research throughout India and as a part of the development programme, training facilities are being expanded to take in about twenty persons at the Nuclear Physics Research Institute, Calcutta, for undergoing training in experimental and theoretical methods in nuclear science for a twenty-month period. A number of countries, including Great Britain, the U.S., the U.S.S.R. and Canada, have offered to provide facilities for training of Indian personnel, supply of literature, procurement of specialised equipment and supply of fuel elements for reactors. Research in India is being directed to the use of thorium as an alternative to uranium for fuelling atomic reactors. While India is short in high-grade uranium, it has the world's biggest thorium resources, derived from an estimated 2,000,000 tons of monazite-bearing sands in Travancore-Cochin, containing about 10 per cent thorium. Two factories with a combined capacity for processing 1500 tons of monazite annually have been put up at Bombay and Alwaye. Another important project, scheduled to start production in about four years' time, is the heavy water plant at Nangal, Punjab, which will yield 250,000 tons of nitro-fertiliser and from 5 to 6 tons of heavy water annually, using power from the Nangal hydro-electric power stations.

African Engineering News

BY OUR SOUTH AFRICAN CORRESPONDENT

Iscor Investigates Possibility of Third Steel Works

Iscor is investigating the possibility of establishing a third steel works in the Union. In the meantime it is planned to increase the combined capacity of both the Pretoria and Vanderbijl Park works to 1,800,000 tons per annum. This scheme would cost about £28,000,000. The changes at the two works would involve the installation of new plant and the modernisation and replacement of some of the existing plant, part of which is more than twenty years' old. The first effects of the proposed extensions should be felt in 1957, but the full scheme would probably not be completed before 1959 or 1960.

More Water for Orange Free State Goldfields

Within two years the water supply to the Orange Free State goldfields will be increased from the present 18,000,000 gallons a day to more than 48,000,000 gallons, as a result of extensions to the Department of Irrigation's works at Balkfontein, which will cost several million pounds, and the building of additional reservoirs at Koppie Alleen. A new reservoir is already under construction at Koppie Alleen, and nine others are planned with a total storage capacity of 90,000,000 gallons. These developments should meet the requirements of the goldfields for some years to come.

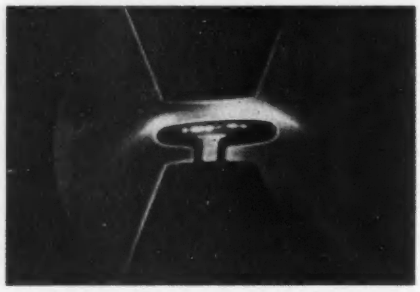
Development in S.A. Gear Manufacture

An agreement has been completed by the Vanderbijl Engineering Corporation (Vecor), of Vanderbijl Park, and David Brown Precision Equipment (Pty.), Ltd., of Benoni, for the joint manufacture of certain gearing products. Under the terms of the agreement Vecor will produce castings and carry out the machining of all heavy gear and pinion blanks required by the two companies, and David Brown Precision Equipment will undertake the gear cutting. It is anticipated that with the resources now available it will be possible to manufacture in South Africa, at competitive prices, a greater volume of the heavy gearing equipment previously imported from overseas.

Continental Engineering News

Oxygen Indicator and Recorder

Continuous indication and recording of the oxygen content of a gas mixture is of great importance in many industries, e.g. where it is necessary to avoid the formation of inflammable or explosive mixtures, or where it is a question of controlling the correct fuel/air ratio of a boiler. An instrument which was designed for such measurements is the "Magnos," made by Hartmann and Braun A.G., Frankfurt/Main, Falkstr. 5. In it, use is made of the difference in thermo-magnetic susceptibility between oxygen and other gases. Oxygen, nitrous oxide, nitric oxide, and two chlorine oxides, are paramagnetic, all other gases being weakly diamagnetic. The paramagnetism of oxygen alone is very much higher than that of the other compounds which have been mentioned, and is in fact unique. This makes it possible to distinguish between oxygen and the rest. The method depends upon the diminution of the paramagnetism with



Schlieren photograph of the cell of an oxygen indicator. Magnetic pole pieces and heating coil are clearly seen, as is the "magnetic wind" on which the functioning depends

increase in temperature. When the sample under investigation is placed in a strong magnetic field, e.g. that of a permanent magnet, the oxygen is attracted to the points of greatest field strength. At the point of greatest field gradient an electrically heated wire is provided for heating the adjacent gas. As the gas rises in temperature its paramagnetism decreases, and it gets displaced by a stream of colder gas with stronger magnetic properties. The resulting continuous stream is called "magnetic wind," and its velocity is nearly proportional to the oxygen content of the measured gas. The wire provided for local heating of the gas is used simultaneously for measuring the velocity of the magnetic wind, by acting as a hot-wire anemometer. The cooling of the wire in the air current affects its electric resistance, the change of which is indicated by a Wheatstone bridge and galvanometer. By a corresponding graduation of the galvanometer it may be made to read the oxygen percentages directly.

In the "Magnus 1" model the sample is drawn through an annular cell with inlet and outlet at opposite ends of a diameter. Halfway along each limb the two limbs are connected by a tube which is partly in the field of a permanent magnet, and which has wound on it, side by side, the two adjacent resistances of the Wheatstone bridge, which simultaneously serve as heating elements.

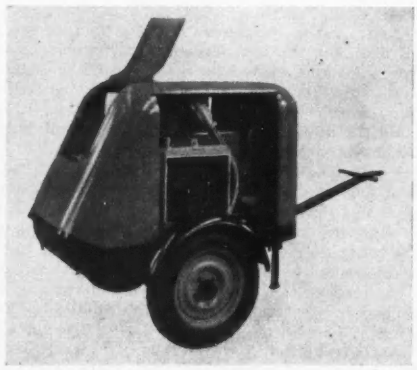
The "Model 5," on the other hand, is characterised by a different design of measuring cell. The gas is passed successively through two identical compartments, one containing the pole pieces of the permanent magnet, the other a set of similar dummy pole pieces. In each case the air gap is surrounded by a heating coil, which is placed inside a thin glass tube for protection from corrosion and catalytic surface combustion. As before, the two coils form the two arms of a Wheatstone bridge. The one placed in the magnetic field is cooled by the magnetic wind, while the other compensates for changes in room temperature. The accompanying illustration is a Schlieren picture of the magnetic chamber. The magnetic wind around the coil is clearly visible by reason of the density changes which occur. Variations in the specific heat, density, viscosity, and thermal conductivity of the gas under test, which to a certain extent affect the sensitivity, can be allowed for by a corresponding calibration, if the approximate composition of the gas is known. The absence of direct contact between the heated wire and the gas obviates the possibility of catalytic ignition of the mixture, if flammable, while the temperature of the heating coil can be kept lower than the ignition point of nearly all inflammable mixtures.

The ranges covered are from 0–1 per cent oxygen, to 0–100 per cent, and either indicating or recording instruments are supplied. While the "Model 1" is intended for stationary use and where large percentages of hydrogen occur, the "Model 5" can be used in vehicles on land, sea or in the air. The time lag of either instrument is stated to be low and to be of the order of a few seconds, so that the instruments are very suitable for automatic control.

Diesel-Driven Air Compressor

We have received particulars of the model "JW 20Kf" portable air compressor manufactured by Jenbacher Werke, Jenbach (Tyrol), which is shown in the accompanying illustration. The machine is a development of the model "JW 15 K," and comprises a single-cylinder, horizontal, four-stroke diesel engine, mounted in one block together with a vertical single-stage compressor. Compared with the former model, the present one has a more powerful engine, with a continuous rating of 20 b.h.p.; this has been achieved mainly by enlarging the inlet valve. The bore of the compressor cylinder has been increased from 125mm to 135mm, giving a swept volume of 2 litres. This corresponds to 106 cubic feet per minute at the rated continuous speed of 1500 r.p.m. The delivery pressure is 85 lb or 100 lb per square inch, and is adjustable.

In this unit the compressor connecting-rod is linked to the engine connecting-rod in a 90 deg. vee arrangement, thus relieving the crankshaft of a great part of the torque and giving extremely smooth running. All moving parts are enclosed in the engine casing and are easily accessible through removable cover plates. Other parts, such as the wet liners, can also be changed easily. The injection pump is also



Single-cylinder air compressor of 78 cubic feet per minute capacity, driven by integral single-cylinder, four-stroke diesel engine

inside the engine casing, and is fed with fuel oil through a filter equipped with felt disc. A single-hole nozzle injects the fuel into a pear-shaped precombustion chamber, in which the combustion is initiated by a small amount of pre-injected fuel. The final combustion takes place in the main combustion chamber. It is claimed for this system that combustion is soft but powerful, and insensitive to the quality of the fuel. For restarting after the engine has run out of fuel, a priming pump has been fitted.

Of special interest is the design of the auxiliary gear, in which the camshaft, arranged in parallel to the crankshaft, drives in succession both valves as well as the injection pump. This layout gives a short camshaft and also avoids the use of bevel gearing. In this way a short and correspondingly strong crankshaft is obtained, and the width of the engine is reduced.

An adjustable-speed governor maintains the engine at 1000, 1200 or 1500 r.p.m., according to which speed is selected by means of a hand lever.

An automatic cut-out governor maintains the working pressure of the compressed air by controlling a valve in the compressor inlet, so that when the set operating pressure is reached in the receiver this valve is closed and the engine remains idling. A longer valve life is achieved by arranging the delivery valve in the compressor head concentrically about the central inlet valve. This gives better cooling of the valve, both by the water jacket and by the aspirated cold air. A common water-cooling system is fitted, both to engine and compressor; the after cooling of the compressed air has been improved considerably by redesigning the tubular air cooler. Ahead of the receiver air temperatures of 140 deg. to 160 deg. Fah. are obtained, so that the compressed air tools are fed with air at a temperature of 120 deg. to 140 deg. Fah., thus reducing tool wear.

Two separate air cleaners are fitted, one for the engine and one for the compressor, with efficiencies of 99 per cent. In exceptionally dusty locations the use of cyclone filters is recommended.

The unit is mounted on a two-wheel trailer, together with the receiver, which is made from 5mm sheet. Normally, the engine is started by hand, but an electrical starter can be supplied.

The agent in the United Kingdom is Chamberlain Industries, Ltd., Staffa Road, Leyton, London, E.10.

Vertical Boring and Turning Mill

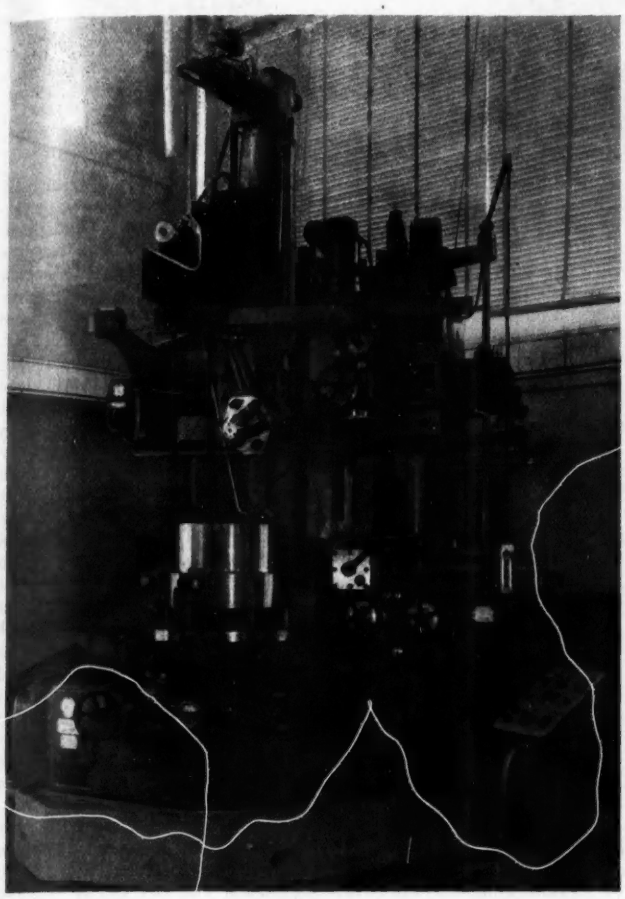
We have received details of the Model 9320/2 vertical boring and turning mill made by S. A. des Anciens Etablissements Charles Berthiez, 5, Rue Montalivet, Paris (8e). An illustration of this machine tool is reproduced opposite; it will be seen that it has a single column set at a fixed distance from the table. The latter is 40in in diameter, and has a range of eighteen speeds of 5 to 250 r.p.m. (or 6·3 to 315 r.p.m., if desired). Maximum swing is 56½in and maximum height of workpiece under the arm is 42in. The table is mounted on taper roller bearings and driven by a large-diameter crown wheel. The gearbox is located in the table housing, the sliding gears being selected by cams by means of a handwheel and lever.

The tool-holder on the arm has a maximum vertical traverse of 36½in and a horizontal traverse of 19½in. According to the customer's requirements the toolhead on the arm can be equipped either with a slide carrying a hexagonal turret or with a rectangular ram for a single square toolholder with a taper shank.

The toolhead on the upright is fitted with a rectangular slide mounting a square revolver turret toolholder. Both toolheads can be swivelled.

Controls, including those for quick displacement, are grouped on the carriages and are independent for each toolhead. Mechanical and electrical safety devices prevent faulty movements, and cut off the current to the main motor if table or gearbox lubrication should fail.

A range of eighteen feeds of 0·0026in to 0·25in per revolution is provided, also a rapid traverse for the toolhead of 40in per minute, and a rapid traverse of the arm of 16in per minute. The main motor is rated at 40 h.p. or 50 h.p., in addition to which there is the motor for elevating



Vertical boring and turning mill with electronic copying attachment. The template is fitted to the cross-rail; in the foreground is the control unit

the arm, rated at 2·5 h.p., and 2 h.p. motors for the rapid traverse of each toolhead.

The machine is fitted with an "S.E.A." electronic copying attachment which controls from a template the two motors which actuate the toolholder. The tracing unit can be placed in either of two positions on the toolhead to suit the work in hand. A force of about 4 oz is exerted by the tracing finger so that mild steel templates can be employed. When not in use, the training unit is withdrawn by an electromagnet to a "rest" position. All controls of the attachment are collected together on the pedestal unit shown in the illustration. The operator can select either automatic or semi-automatic motion of the tool post. The semi-automatic working, the direction and speed of the tool are selected by means of two knobs. A warning light indicates any error made by the operator. If the feed lever is used during copying work the tracing stylus at once moves into the "rest" position so as to avoid being damaged. The changeover from normal machining to copying, and vice versa, is stated to take no more than fifteen seconds, no mechanical rearrangement being necessary.

International Trade Fairs

A number of measures to overcome difficulties in the organisation and conduct of international fairs have been proposed by the E.C.E. Working Party on International Fairs at its recent meeting at Geneva. These proposals concern the question of visas for exhibitors, their technical staffs, and prospective visitors, facilities for obtaining currency, the abolition of duty on publicity material and customs provisions concerning materials for the construction and decoration of stands. Proposals were also made with regard to the sale of goods exhibited as well as concerning quotas for goods ordered. Final decisions are to be made public after the E.C.E. Trade Committee session to be held next autumn.

One of the chief difficulties is the drawing up of a calendar for the constantly increasing number of fairs which describe themselves as international, thirty-seven of which will be held in Europe during the coming eight months. They put a heavy strain on private economy. Different views were expressed to the working party as to the appropriate scope for governmental interest in, and interference with, exhibitions and trade fairs. This aspect is to be discussed further by the E.C.E. Trade Committee at its next meeting. The Working Party will meet again in June to take up the questions of transport facilities for persons and goods in connection with international fairs, as well as various problems of organisation. Besides the joint commission of the Union of International Fairs (U.I.F.) and the International Chamber of Commerce (I.C.C.), representatives of the following countries took part:—Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, Finland, France, German Federal Republic, German Democratic Republic, Italy, Luxembourg, The Netherlands, Norway, Poland, Rumania, Sweden, Switzerland, the United Kingdom, the United States of America, and the U.S.S.R.

Electrification of the Saar Railways

A total of 18 milliard francs is to be spent on the electrification of 200km of railway in the Saar. Of this amount, a sum of 1 milliard francs is to be spent in the current year on preparatory work. The Saar finance committee is reported to have recommended immediate negotiations with the German Federal Railway authorities about the system to be adopted, so that after the return of the Saar to Germany the work can be continued without delay by the German railways. In deciding on whether to adopt the 50 c/s, 25kV system, attention will have to be paid to the views of the commission which has been set up by the Belgian, Luxembourg, German, French, and Saar railways to co-ordinate railway electrification schemes in the common frontier regions of these countries. According to press reports, agreement has been reached so far that the lines from the important shunting yard Ehrans near Trier to Lorraine and Luxembourg should be electrified with 50 c/s current, which is to be introduced this year on the line from Thionville to the Saar frontier at Forbach. The commission is reported to have been in favour of the 50 c/s system on all Saar main lines.

The Testing of Gas Mains for Leaks

A remarkable instance of increased productivity is reported from Utrecht where an amount of work which was previously done by four operators in a day can now be carried out by two in fifty minutes. It might be thought that such an improvement could only be achieved by the introduction of elaborate machinery or instrumentation. This, however, is not the case. The work referred to is the detection of leaks in gas mains. Where formerly three-quarters of a kilometre could be checked in a day by four men using standard detection devices, the same length of mains can now be dealt with by one man and a dog which has been trained for the job. Not only is the dog's nose more sensitive to gas than the usual instruments but the dog can be trained to indicate by his behaviour the degree of leakage. It has been found necessary to carry out these tests at times of weak road traffic, i.e. before 8 a.m., so as not to allow the dog's attention to be distracted. If no leaks are found, the cost of testing is stated to be about one thirtieth of what was formerly incurred.

International Building and Public Works Exhibition

The eleventh International Building and Public Works Exhibition is to be held in Paris from June 16th to 28th. It will comprise the following sections:—Machinery for construction purposes and preparation plant, including special purpose vehicles, vibration and ramming equipment, dewatering plant, road building equipment, and small plant for building sites; building materials of all kinds, including reinforcements, insulation, and paints, and gas, electrical and sanitary fittings; instruments for civil engineers, surveyors and architects, and an information section illustrating the state of building science in the participating countries.

The exhibition site is at Paris-St. Cloud, and covers a total area of 15 hectares. Full information can be obtained on request from the London representative, R. C. Liebman, 178, Fleet Street, E.C.4.

Belgian Hydro-Electric Equipment

For the "Le Marinel" hydro-electric power station at Katanga, Belgian Congo, Ateliers de Constructions Electriques de Charleroi (ACEC), are building four alternators of 69MVA, 10·5kV, 333 r.p.m. each. These, it is stated, are the largest units of this kind to be built in Belgium. In order to be able to construct the corresponding turbines, ACEC has put in hand an extension of its heavy engineering workshops which will increase the available floor space by 20 per cent. Among the machine tools which will be installed, will be a 730-ton vertical boring mill which, it is said, will be the largest in the country. It will be capable of machining workpieces up to 18m in diameter and 5m high, and will be equipped with a main motor of 380 h.p. Its 730 tons required sixty railway wagons for transportation. The machine will rest on 580 cubic metres of concrete foundations which have a thickness of 6m.

Swedish Steel Production

Compared with 1954, Sweden's output of pig iron last year increased by 25 per cent to 1,173,000 tons, while sponge iron went up by 42 per cent to 74,000 tons. The output of steel rose by 15 per cent to 2,125,000 tons, and of commercial iron and steel by 20 per cent to 1,502,000 tons.

Since 1937, the first year in which steel output reached 1,000,000 tons, production has more than doubled. This increase has taken place almost entirely since 1947, when the output totalled 1,200,000 tons.

Exports of commercial iron and steel showed an increase of nearly 50 per cent to 262,000 tons, most of it being accounted for by hot-rolled products.

Shipping Traffic at Basle

Last year the total tonnage of goods passing through the Rhine ports at Basle amounted to just over 4,587,000 tons, only slightly below the record figure for 1951, which would almost certainly have been exceeded but for the floods at the beginning of the year and the low water and fog during the last quarter. Of the total, nearly 4,131,000 tons (90·1 per cent) were imports into Switzerland. Merchandise passing through the Basle ports accounted for 37·7 per cent of the total Swiss foreign trade. If transit traffic is deducted, goods arriving by boat constitute 34·3 per cent of all Swiss imports.

German Coal Consumption

An increase of over 9 per cent is reported in last year's consumption of coal in the German Federal Republic, as compared with 1954. This is accounted for by an increase of nearly 24·5 per cent in the iron and steel industry, a 6 per cent increase in the remaining industry, and an increase of over 11 per cent in the consumption in gasworks.

The American Scene

BY OUR AMERICAN EDITOR

PROGRESS IN ATOMIC ENERGY

THE report by a panel of laymen on the "Impact of the Peaceful Uses of Atomic Energy" which was submitted recently to the Joint Congressional Committee on Atomic Energy must be regarded as one of the most important American public documents issued in recent years. It reviews what has been done thus far with atomic energy in power production and in advancing medicine, agriculture and industry; it examines and, in general, approves the policy which has been laid down by Congress in the Atomic Energy Act; it recommends modifications which would do away with unnecessary secrecy; it praises the Atomic Energy Commission for the manner in which it has performed the difficult task of meeting both military and civilian needs. To prepare the report, fifteen discussion groups were convened, some fifty special studies prepared, and 327 authorities consulted. What it constitutes then, is a cross-section of the best available opinion on the present state of atomic knowledge, so far as it can be applied in industry and for general practical purposes, the kind of cross-section that a business man, an investor or, for that matter, the general public needs to judge what lies before us in 1975, by which time, it is generally agreed, atomic power will play a conspicuous part in our daily lives. There are many questions that need to be answered. When will America have atomic power stations? What will happen when radioactive isotopes play their part in increasing the output of crops at a time when the United States is perplexed by the problem presented by a farm surplus? What part can private enterprise play in developing atomic energy for civilian purposes? Scores of such questions arise. There is no attempt at evading answers in meaningless generalities. The report makes positive, constructive recommendations.

In the first place, there is the Atomic Energy Act. Though the doctrine on which it is based is accepted, the need of a revision that goes beyond the liberalisation of 1954 is recognised. Until the fear of another world war is dispelled America cannot afford to weaken the military safeguard essential to the preservation of national security. However, access to information that designers of atomic power plants must have is difficult to obtain, which suggests that all reactor technology should be freely published. These and similar recommendations have been made before by scientists and engineers. They gain new strength by their repetition in this important official document. Secrecy in the industrial field is an obstacle to the development of atomic energy for peaceful purposes, and the report emphasises the fact. Secrecy was imposed during the period when the first atomic bombs were developed. It has been maintained ever since for reasons no longer valid. For a few years America had a monopoly of the knowledge and technical skill required to build and operate reactors in which explosive atomic material is produced as well as heat, and she alone had a stockpile of atomic bombs. That monopoly was broken by Russia, as the scientists predicted from the beginning that it would be. The plain truth is that to-day the United Kingdom, Soviet Russia and other countries know as much as the Americans do about reactors, power production and the many ways in which radioactive isotopes can be utilised in medicine, agriculture and industry. Yet military policy still dominates official American thinking. As the report points out, it is assumed that any discovery or advance in nucleonics must be classified or kept secret from the moment of birth. The absurdity of this policy was brought out at last summer's Geneva Conference on the Peaceful Uses of Atomic Energy, a conference convened at the suggestion of President Eisenhower. The scientific representatives of seventy-two nations were on hand to discuss and listen and learn. It was agreed beforehand that nothing of civilian importance was to be held back. It turned out from the discussions that what the great powers had been hugging as secrets were not secrets at all. Scientists everywhere in Europe were developing atomic energy for peace. They had been working along the same lines and arriving at much the same results. The argument of the report against secrecy does not follow the lines laid down by scientists years ago. It is more or less new in that it is concerned with the economic and social effects of keeping secret what every atomic physicist and nuclear engineer in the world has long known. In the first place, the report emphasises the importance of free enterprise in developing the peaceful applications of atomic energy. Lewis L. Strauss, chairman of the Atomic Energy Commission, has been doing his best to turn the atom over to private companies for exploitation. But, as the report points out, free enterprise and secrecy that has nothing to do with military weapons are incompatible. Competition between private companies is partly based on getting information on new developments and making use of it. That is how business enterprises grow. But the application of atomic energy in industry cannot become big business if unnecessary secrecy stands in the way. To make the course of free enterprise easier the report would throw reactor technology open to all. Unless this is done it will be difficult to bring about the co-operation of industry and government in the way that Mr. Strauss regards as a necessity in the development of the peaceful atom. It is true that the Atomic Energy Commission and private companies are together building the first large American commercial atomic power station at Shippingport, Pennsylvania. But it is also true that the station will be obsolete before it is completed. The report urges a revision of the Atomic Energy Act to grant free access to technical information except to that which ought to be kept secret as a matter of military prudence. There are scores of firms in the United States that can design and build an ordinary steam power station. The information that their designers need is taught in the technical schools and discussed in the meetings of technical societies. So should it be with reactor engineering, the report holds.

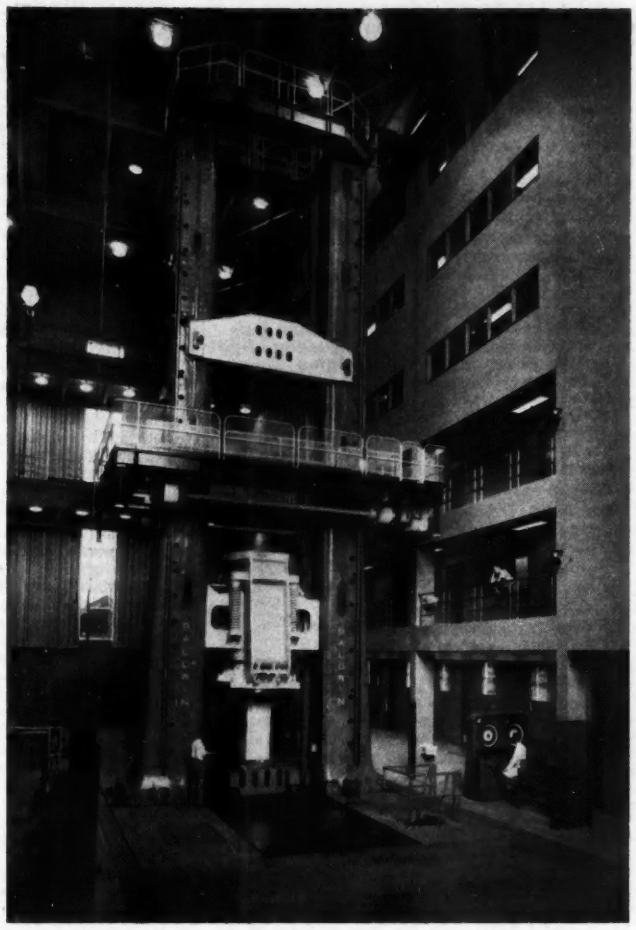
Far as free access to many secret documents would go in stimulating the growth of atomic power plants, America must go farther. An ordinary power station without fuel would be useless. So would a reactor without uranium, plutonium or thorium. Hence the report would remove all restrictions on the sale of fissile material. It wants a free market. Given such a free market not only in fissile material but in reactors, American engineering firms could sell reactors and fissile material anywhere and in this way carry out President Eisenhower's plan of helping nations that lack fuel resources to improve their economies and raise their depressed standards of living. There is hardly any secrecy in medical research based on the use of radioactive materials, or in agricultural and scientific research not directly concerned with such matters as getting more energy out of the atom. The atomic Energy Commission is fully aware of the difficulties that have been raised by the military thinking that influenced the framers of the Atomic Energy Act even in its liberalised form of 1954. The commission grants access to confidential information to a few firms that are not regarded as security risks. So far about 600 organisations have received such permits. This is an anomaly. If there is anything in secret information that would give aid or comfort to a potential enemy no one should have access to it; if it contains no such information and access can be safely granted there is no reason for secrecy. This dominance of military thinking hurts even the Atomic Energy Commission, in the opinion of those who wrote the report. They doubt if the A.E.C. can make full use of the immense amount of classified material in its own files. For the A.E.C., it must be said that it is doing its best to make accessible the thousands of documents in which the results of research that it has initiated and paid for are described. The task is formidable. According to the report the commission is now reviewing 28,000 secret documents with possible release in mind—a process that may well take several years. It is plain that if the United States is to do away with unnecessary secrecy the concept will have to be abandoned that any advance in the application of atomic energy must be regarded as "born" secret. There are military matters that cannot be disclosed, but there are also hundreds of industrial suggestions for the utilisation of atomic energy that should be freely published. Taken as a whole, the report lays down the policies that ought to be followed in developing the peaceful atom. This means above all a reconsideration of the Atomic Energy Act. It is the conviction of the panel that unless public opinion is thus expressed and heeded America will find it difficult to maintain her present leadership in the exploitation of atomic energy.

5,000,000 lb Universal Testing Machine at Lehigh University

THE accompanying photograph shows the 5,000,000 lb universal testing machine which recently went into operation at the Fritz Engineering Laboratory of Lehigh University, Bethlehem, Pennsylvania. Considering its load capacity and the size of tension, compression and flexure specimens it can accommodate, the testing machine is believed to be the largest of its kind in the world. The unit was built by the Baldwin-Lima-Hamilton Corporation, Eddystone, Pennsylvania, to specifications prepared by Lehigh University. The new machine stands 60ft above the test floor and 16ft below it, making it 76ft high. A block of concrete 18ft thick below the pit provides an anchorage weighing 2000 tons. The space between the two vertical columns is 10ft, and the total weight of the structure exclusive of foundation is approximately 400

tons. The illustration clearly shows where specimens are secured during tension and compression tests. These specimens may be as high as 40ft, as long as 100ft and almost 10ft wide.

Loads are applied hydraulically by a movable cylinder on a stationary, 54in diameter, 36in stroke piston. The hydraulic pressure at maximum load is 2200 lb per square inch. The two vertical screws, through which loads are applied to specimens, apply loads on test pieces at rates up to 3in per minute. These screws are 62ft long and 16in in diameter, weigh nearly 20 tons each, and are believed to be the largest of their kind ever made. The screws are rotated by a 75 h.p. electric motor, and are used to position the crossheads. The sensitive crosshead acts as an elevator for positioning the tension crosshead. The load-measuring system is the hydraulic Emery cell-made by the A. H. Emery Company, New Canaan, Connecticut. This cell is 56in in diameter, is mounted in the sensitive crosshead and through flexible tubing operates a null-balance Tate-Emery indicating system in the control console.



Baldwin 5,000,000 lb universal testing machine at the Fritz Engineering Laboratory of Lehigh University performing compression test

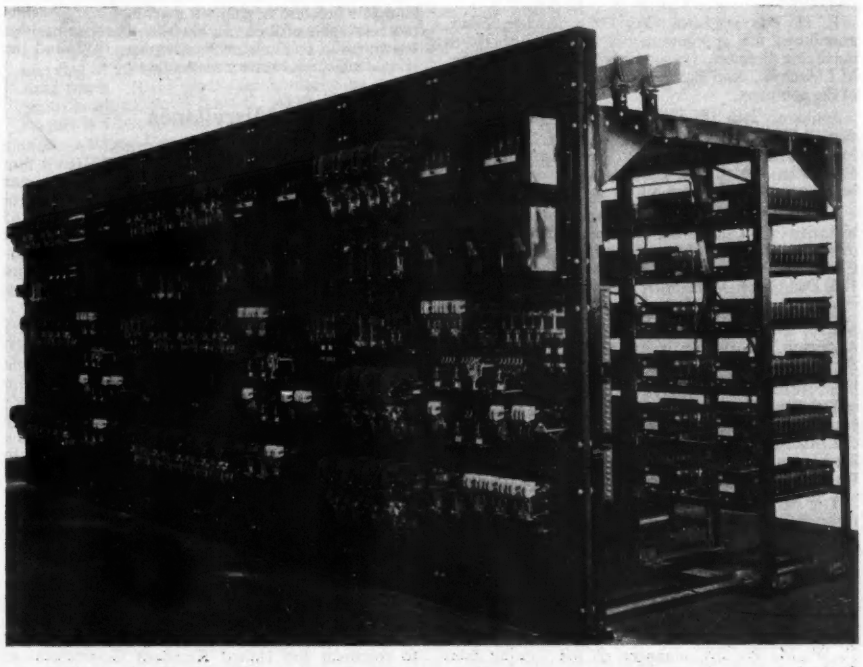
The Emery cell is a shallow cylinder with a loose-fitting piston and a metal diaphragm. The load on the test specimen produces a pressure change on a film of oil trapped between the piston diaphragm and the bottom of the cylinder. It is this oil pressure which is transmitted through a line that eventually causes operation of the null-balance system with its dial indicators. The hydraulic loading pressure is applied by a 50 h.p. electric-motor-driven radial piston and variable discharge pump of 3000 lb per square inch capacity. Oil is pumped at the rate of 33 gallons per minute from a 460-gallon reservoir to the main loading cylinder or to a pair of 15in diameter pull-back cylinders, and to backlash eliminators on the sensitive crosshead. After a test load is applied the sensitive crosshead, vertical screws, and hydraulic cylinder are returned to the starting position at 18in per minute by two auxiliary hydraulic pull-back cylinders. These cylinders are bolted to the main cylinder casting with open end down. The two stationary rams in these cylinders rest on spring-cushioned crossheads, each of which is supported by two tension rods from the base structure. The weight of this assembly rests on these cylinders when the testing machine is not in use.

Automatic Screwdown Controls for Dorman Long Beam Mills

A SET of automatic positioning screwdown control equipment was recently shipped to England by the Electric Controller and Manufacturing Company, Cleveland, Ohio, for the new broad-flanged beam mills now under construction at the Middlesbrough works of Dorman Long and Co., Ltd. These mills will utilise the two contant-potential automatic positioning screwdown controllers to schedule automatically the separate roughing and finishing operations. Each of the controllers uses schedule panels equipped with slider contacts for preselecting complete rolling schedules. Once the easily adjusted sliders are properly positioned for the desired mill roll openings the mill operator has only to press a momentary contact button once for each mill pass. The pressing of this button actuates the horizontal, vertical and edger roll drives of the mill in unison, with automatic-positioning control stopping the drives to give the exact roll separation for the particular pass as called for by the schedule panels. The positioning of the slider contacts on the schedule panels is facilitated by simple graduated scales, with one main scale and pass sliders and one vernier scale and pass sliders provided for each mill pass up to the maximum required, depending upon the particular mill operations for which the individual screwdown controller is designed.

The automatic positioning screwdown controllers are arranged to be coupled to the roll movement of the mill at any point within its capacity, thus making possible automatic roll scheduling for virtually any size of beam. In addition, manual control of any or all roll movements is instantly available to the operator by means of a master switch which cuts out the operation of the automatic positioning control. This automatic control, however, remains coupled to the roll movements during manual operation, so that the operator can return to the preselected rolling schedule whenever he desires. If manual control is used to finish the rolling which was first started using automatic positioning, a " Return-to-One " button is provided for resetting the automatic control to the No. 1 pass on the schedule panels. Electrical coupling of each automatic positioning screwdown controller to the screws on the mill is effected by synchronous tie-motors. Three tie-motors, called transmitters, are mounted on the mill and are geared to the horizontal, vertical, and edger roll drives. Three additional tie-motors, called receivers, are mounted in the control room or operator's pulpit and are geared to cut-out mechanisms incorporated in the screwdown controller assembly.

During operation when the contact push button is pressed to begin a particular mill pass, the motors drive the rolls until the transmitter tie-motors synchronise with the receiver tie-motors connected to the cut-out mechanisms, the precise synchronisation point having been set up automatically with the adjustment of the slider contacts on the graduated main and vernier scales of the schedule panels. At the instant of synchronisation the controller cut-out mechanisms trip, stopping the rolls at the exact separation called for by the schedule panel selectors. An electronic balance anticipator and cam cut-out mechanism are employed in the controller to slow down the motors driving the screws as the rolls approach the preselected roll opening point for the particular pass. In the event of over-travel, the drives are " plugged " under the control of the cam cut-out mechanism.



Automatic positioning screwdown control for broad-flanged beam roughing mill at the Middlesbrough works of Dorman Long and Co., Ltd.

Personal and Business

Appointments

MR. R. F. HUNT has been elected a director of Dowty Group, Ltd., Cheltenham.

MR. D. R. MACKIE has been appointed managing director of Monsanto Chemicals, Ltd.

GROUP CAPTAIN R. C. HOCKEY has been appointed director and general manager of Blackburn (Dumbarton), Ltd.

THE BRITISH TRANSPORT COMMISSION has announced the appointment of Mr. J. B. Baxter as estate and rating surveyor, Scotland.

MR. F. A. POPE has been elected chairman of John Bull Rubber Company, Ltd., following the retirement of Mr. John C. Burton.

DR. N. CARPENTER, A.M.I.Mech.E., has been appointed manager of the technical sales department of Ferodo, Ltd., Chapel-en-le-Frith, Stockport.

LONDON TRANSPORT states that Mr. J. D. Watson, M.I.C.E., has been appointed principal executive assistant in the office of the assistant civil engineer (structures).

MR. R. C. THOMPSON, chairman of Joseph L. Thompson and Sons, Ltd., has been elected president of the North East Coast Institution of Engineers and Shipbuilders.

MR. N. P. NEWMAN, chairman and managing director of Newman Hender and Co., Ltd., has been re-elected chairman of the Council of Iron-foundry Associations.

DR. J. THOMSON, M.I.E.E., has been appointed director of the British Scientific Instrument Research Association, in succession to Mr. A. J. Philpot, who will retire next month.

GUEST KEEN AND NETTLEFOLDS, Ltd., has announced the appointment of Mr. W. Waring as a director of Brymbo Steel Works, Ltd., and of Guest Keen Iron and Steel Company, Ltd.

MR. D. B. WRIGHT has been appointed sales manager in the industrial division of Kerry's (Great Britain), Ltd., Warton Road, London, E.15, in succession to Mr. A. H. Watts.

THE POWER-GAS CORPORATION, Ltd., Stockton-on-Tees, states that Major W. R. Brown has been elected vice-chairman. Mr. T. K. Hargreaves, A.M.I.Mech.E., has been elected a director.

MR. JOHN MEAGER has been appointed works office manager at the Plymouth works of Acheson Colloids, Ltd. Mr. D. E. H. Hamilton and Mr. E. Matthews have been appointed technical sales representatives.

WHESSOE, Ltd., Darlington, announces the following appointments : Mr. R. F. Bishop, A.M.I.Mech.E., chief engineer (special developments), and Mr. D. S. Hudspeth, A.M.I.C.E., chief engineer (petroleum equipment).

E. H. BENTALL AND CO., Ltd., Maldon, Essex, announces the appointment of Mr. J. Roberts as managing director. He succeeds Mr. D. P. Ransome, M.I.Mech.E., who has relinquished his directorship of the company.

JOHNSON AND PHILLIPS, Ltd., Charlton, London, S.E.7, states that Mr. G. T. W. Whitehead, M.I.Mech.E., general manager (works), and Mr. J. B. McRostie, A.M.I.E.E., general sales manager, have been appointed directors.

MR. P. H. BROWN has been appointed sales representative in Lancashire, Cumberland and Westmorland, of The Universal Asbestos Manufacturing Company, Ltd., Watford, Herts. His address is 196, Deansgate, Manchester.

AT the annual general meeting of the Institute of Marine Engineers, held on April 24th, Sir Donald Anderson, the deputy chairman of the P. and O. Steam Navigation Company, was elected president, in succession to Mr. H. A. J. Silley.

THE BRUSH GROUP, Ltd., announces the forthcoming retirement of Sir Ronald Matthews from the chairmanship. He is to be succeeded by Mr. G. C. R. Eley, who is at present the deputy chairman. Sir Ronald will continue to serve as a director.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND has elected Sir Harold E. Yarrow, Bt., chairman and managing director of Yarrow and Co., Ltd., as president and appointed Mr. George Morrison and Mr. John Robson as vice-presidents.

A.E.I. LAMP AND LIGHTING COMPANY, Ltd., announces the following appointments : Mr. W. C. Huston, manager of the lamp sales division ; Mr. C. W. M. Phillips, manager of the lighting sales division, and Mr. O. W. J. Farmer, manager of the publicity division.

WADKIN, Ltd., Leicester, states that Sir Holland Goddard is retiring from the position of chairman and joint managing director, but will continue to serve on the board. At the next annual meeting, Sir Holland is to become president of the company which he has served for over forty-four years. Mr. J. B. Bullivant has been appointed chairman and Mr. L. Austin, managing director.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has announced the following appointments : Mr. J. E. A. Heale, works manager, Motherwell works ; Mr. E. Turnbull, superintendent, and Mr. R. W. D. Jack, assistant superintendent, of the instrument and meter department, Trafford Park ; Mr. F. B. Lawrence, assistant superintendent of the meter department, and Mr. G. L. Brown, assistant superintendent of the X-ray department, Motherwell works.

Business Announcements

DEWRANCE AND CO., Ltd., Great Dover Street, London, S.E.1, has formed a special alloys division.

THE MINERVA DETECTOR COMPANY, Ltd., has moved to Lower Mortlake Road, Richmond, Surrey (telephone, Richmond 6431).

BLACK AND DECKER, Ltd., Harmondsworth, Middlesex, has opened a new branch office at Knott Mill, Manchester, 15 (telephone, Blackfriars 8865).

E. I. DU PONT DE NEMOURS AND CO., Wilmington, U.S.A., announces the formation of a British subsidiary entitled Du Pont Company (United Kingdom), Ltd.

RICHARD THOMAS AND BALDWINS, Ltd., has set up an operational research department, to serve all sections of the business, with its headquarters at the Ebbw Vale works. Mr. S. L. Cook is in charge of the department.

MATHER AND PLATT, Ltd., Park Works, Manchester, has announced the retirement from the board of Mr. R. C. Mather, whose special interest has been the general and textile finishing machinery department. He joined the firm in 1905.

MARSH BROTHERS AND CO., Ltd., Ponds Steel Works, Sheffield, has announced the retirement of Mr. Ernest Latham, who has been manager of the home sales department since 1928. Mr. Latham has completed forty-nine years' service with the company.

Contracts

C. A. PARSONS AND CO., Ltd., Newcastle upon Tyne, 6, has received an order from the Saskatchewan Power Corporation, Canada, for two 66MW maximum and economical rating turbo-generators, with condensing plant and feed water heaters, to be installed in the new Boundry dam power station, Saskatchewan. The contract provides for the supply, delivery and complete erection of the two machines and amounts to a total value of about £1,200,000. The first machine has to be in commission by October, 1958, and the second machine twelve months later.

Miscellanea

WIDE-SCREEN CINEMA PROJECTION.—A simple modification to G. B.-Bell and Howell 16mm film projectors, the incorporation of a redesigned rear aperture plate or pressure pad assembly in place of standard parts, allows a picture aspect ratio of 1·85 instead of 1·33 for projection in small cinemas. For larger locations a wide angle lens may be desirable. Details of the conversion are available from G.B. Equipments, Ltd., Mortimer House, Mortimer Street, W.1.

ROYAL SHOW.—The Royal Agricultural Society has stated that the total space booked by the 600 exhibitors at its forthcoming show at Newcastle upon Tyne, in July, amounts to 1,250,000 square feet. There were thirty-four entries for the Society's silver medal award for new implements, and seventeen of them have been accepted for judging, subject to a test report being available before the show. In addition, there are three entries which were deferred by the judges last year.

FIFTH WORLD POWER CONFERENCE.—The British National Committee of the World Power Conference has issued a booklet giving details of the general reports and papers which are to be presented at the Fifth World Power Conference, to be held in Vienna in June. About 260 papers are listed (i.e. those submitted by January 10th) from thirty-five member countries. Sir Harold Hartley has been appointed to represent the United Kingdom Government at the Conference, and Sir John Hacking will be the official delegate of the British National Committee.

LARGE PRESS BRAKE.—A 320-ton hydraulic press brake, weighing 43 tons, made by Weldall and Assembly, Ltd., of Stourbridge (Worcs), has a forming capacity between frames of 16ft by $\frac{1}{16}$in, which is increased to 19ft by $\frac{1}{4}$in, using the overall die length. The machine is of welded plate construction and is powered by a 45 h.p. motor, the working pressure being 5700 lb per square inch. The pumps, motor, oil tanks and valve gear are carried high up in the crown of the machine, and it is controlled by a portable electric foot switch and selector buttons, mounted on a control panel.

" LUBRICATION IN INDUSTRY."—A new film entitled " Lubrication in Industry," made by the film unit of Shell-Mex and B.P., Ltd., was recently shown in London for the first time. Introduced by Mr. H. Cunliffe, general manager, industrial fuels, the film stresses the need for close co-operation between the engineer and the lubricants specialist and pays tribute to the industry's research workers. The lubrication of a power station in Austria, a steel works in Genoa and a rolling mill in County Durham are but three of the interesting plants covered. The film is available in 16mm and 35mm sizes.

PORTABLE ELECTRIC SAWS.—Black and Decker, Ltd., Harmondsworth, Middlesex, recently introduced two new light-weight, heavy-duty portable electric saws for which various kinds of blades are available for the cutting of different materials, ranging from wood to cast iron and marble to plastics. The 6in machine weighs 10¼ lb, runs at 5500 r.p.m., and cuts up to 2in deep. The new 7in machine, which weighs 11½ lb, runs at 4200 r.p.m. and cuts up to 2$\frac{7}{16}$in deep. Each saw has a telescopic lower blade guard which closes automatically as the machine is lifted off the work, and is fitted with built-in bevelling and depth-cutting adjustments.

USK AND WEIR WOOD RESERVOIRS.—A colour film entitled " Rivers of Life " has been made by Richard Costain, Ltd., and was recently shown in London. The film opens with the inauguration of the Usk reservoir by Her Majesty the Queen on August 6, 1955, and is followed by sequences, taken over a period of five years, showing the construction of the two earth banks with their concrete and clay seals. Of particular interest is the method adopted to relieve excess pressure built up by pore-water within such banks. A description of the Usk dam was published in our issue of August 12, 1955, and of Weir Wood reservoir in our issue of September 23, 1955. This film is available in 16mm size.

IRON AND STEEL INSTITUTE.—The eighty-seventh annual general meeting of the Iron and Steel Institute is to be held on Wednesday and Thursday, May 16th and 17th, at the Royal Institution, Albemarle Street, London, W.1. It will be preceded by a meeting (at the Royal Institution) on Tuesday, May 15th, at 6.30 p.m., when Mr. James Mitchell will deliver a Bessemer centenary lecture. The morning session, on Wednesday, May 16th, will begin at 9.45 a.m. with the formal business of the annual meeting. Dr. H. H. Burton will be inducted as president and will deliver his address, after which the ninth Hatfield memorial lecture, entitled " The Fracture of Metals," will be given by Professor N. F. Mott, F.R.S. At the afternoon session, beginning at 2.30 p.m., two papers on the acid Bessemer process are to be discussed, and a colour film entitled " Steel Road " will be shown. The annual dinner of the Institute will be held at Grosvenor House, Park Lane, on Wednesday evening, May 16th, at 7 for 7.30 p.m. The meeting will be resumed on the following day at 9.45 a.m. and 2.15 p.m., when further technical papers will be presented for discussion.

NON-FERROUS METALS RESEARCH.—The British Non-Ferrous Metals Research Association has issued its thirty-sixth annual report which surveys the work accomplished during 1955. In a general review of the Association's activities, the report says that the restricted funds and the limited amount of manpower available last year curtailed the volume of research work, with the result that a number of problems, including some of considerable urgency, had to be left out of the programme of work. But in spite of these difficulties, researches on a variety of subjects were pursued or brought to successful conclusion. The Association's annual luncheon was held at the Savoy Hotel, London, on Thursday of last week, April 26th. The chairman of the council, Dr. Maurice Cook, presided, and the principal speaker was Sir Edward Boyle, Bt., Economic Secretary to the Treasury. In a speech proposing the toast of " The Association," Sir Edward emphasised the importance of technical education, and the need to maintain co-operative research and development in all branches of industry. The toast of " The Guests " was proposed by Mr. W. F. Brazener, and acknowledged by Lord Baillieu.

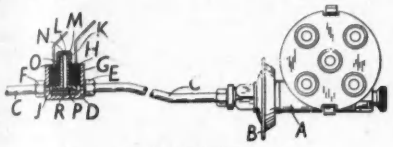
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

INTERNAL COMBUSTION ENGINES

744,391. September, 25, 1953.—IGNITION CONTROLS, Henry Weslake, Harbour Road, Rye Harbour, Sussex.

The invention relates to an ignition control for internal combustion engines of the kind in which means responsive to increase of engine speed and means responsive to increased suction in the induction system are arranged separately or together to advance the ignition. In the drawing, the usual centrifugal



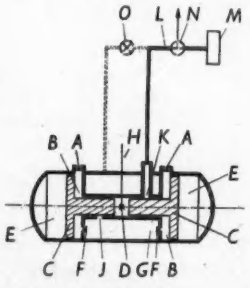
No. 744,391

governor controlling the advance and retarding mechanism for the ignition is indicated at *A* and has an over-riding control in the form of a diaphragm motor *B*, which is connected by a pipe line *C* with the induction system. According to the invention, the pipe line is connected directly with the induction pipe (not shown). In the pipe line is a valve casing *D* of hollow cylindrical form, closed at one end and having connections *E* and *F* on either side near that end, for attachment with the pipe line. In the upper part of the casing is an electro-magnet, the coil *G* of which is connected either directly to the output terminals of the dynamo, or is connected to the battery through a switch actuated by the usual cut-out associated with the charging circuit. The core of the electro-magnet comprises a hollow stem *H* and a head *J* arranged on the underside of the coil while the stem projects from the upperside of the coil and is threaded to receive a cap *K* having a central aperture *L*. A disc *M* with a small bleed hole *N* is arranged between the end of the stem and the cap. The stem also projects through a cover plate *O* at the upper end of the valve casing *D*, and is held in position by a small nut. The under face of the head is recessed at *P* so as to form an annular valve seat. Within the bottom end of the valve casing is an armature in the form of a disc *R*. So long as the coil is not energised, the disc lies on the bottom of the valve casing, the interior of which is in communication with the atmosphere, through the bleed hole, and thus suction from the induction manifold is not placed in communication with the diaphragm motor, and the ignition is in a retarded condition. Should, however, the coil become energised upon increased speed of the dynamo the disc is drawn up by magnetic attraction, on to the valve seat, closing the valve casing to atmosphere and the suction from the induction manifold operates the diaphragm to advance the ignition.—*February* 8, 1956.

MARINE ENGINEERING

747,423. July 22, 1953.—PROPELLING SHIPS BY MEANS OF A LIQUID JET, Compagnie Electro-Mecanique, 12, Rue Portalis, Paris (Seine), France.

The liquid jet ship propulsion plant, according to the invention, comprises in combination a free-piston gas generator, an injector to impel the liquid jet with a gaseous fluid and a pipe to supply the injector with



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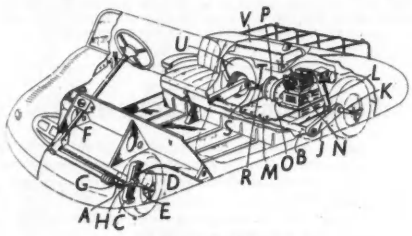
gaseous fluid tapped from the combustion gas outlet and with the scavenging air which escapes from the free-piston gas generator. As shown in the drawing, the air sucked at atmospheric pressure through the valves *A* fills the chambers *B* on the inner side of the pistons *C*. In the course of this suction stroke, which corresponds to the expansion of the combustion gases within chamber *D*, the cushion of gaseous fluid enclosed in the closed chambers *E* is compressed, whereafter it expands again. The pistons *C* are then caused to compress the air previously sucked into the chambers *B* and to force it through the valves *F* into the chamber *G*. The air present in cylinder *D* is carburetted by a fuel injecting device represented diagrammatically by a spraying nozzle *H*. The compressed combustible mixture thus obtained in chamber *D* is ignited, then expanded. Towards the end if the expansion stroke the orifices *J* and *K* are uncovered, and the air stored under a pressure in chamber *G* provides for the scavenging of the cylinder *D*. Some of the air remains in the cylinder to repeat the cycle of operation. According to the invention, the combustion gases and the scavenging air escape through a pipe *L* through which the device *M* for the injection of the gaseous fluid is supplied, the desired propulsion pressure being obtained by suitably dimensioning the injection device. A release-and-control valve *N* may be provided in the pipe *L* to make starting easier. Moreover, an adjustable by-pass *O* may be provided between chamber *G* and pipe *L* to control the temperature of the gases supplied to the injection device *M*. The drawing shown is only given for the purpose of exemplification, and it remains within the scope of the invention to combine a ship propelling plant with a free-piston generator unit in which the component parts are arranged differently.—*April* 4, 1956.

ROAD TRANSPORT

747,345. July 22, 1952.—LIGHTWEIGHT VEHICLES, Josef Ehrlich, 35, Tarranbrae, Willesden Lane, London, N.W.6.

The invention has among its objects to provide a lightweight vehicle which can be easily handled and maintained, has low petrol consumption, and which at the same time is cheap to produce and is mechanically efficient. As will be seen from the drawing, the chassis of the car is of light steel sheet, pressed to box form so that it has a floor with sides and, if desired, a lower floor. For strengthening purposes the floor is ribbed, and on it or integrally with it, is built a raised platform for the support of a seat. At its front and rear the chassis is formed with integral tubes *A* and *B*. Secured to each end of the front chassis tube *A* is a yoke *C*, between the arms of which



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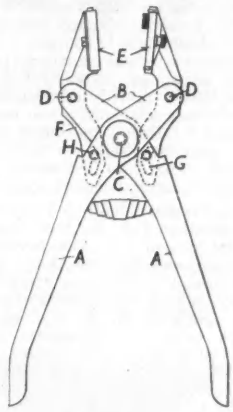
is secured a spindle *D* on which is mounted, between helical springs, a stub axle *E* carrying the front road wheel. Steering is effected in normal way from the wheel through a column *F*, a rack and pinion steering box track rod *G* to a member *H* which forms a bell-crank lever with the stub axle *E*. Pivotally mounted on each end of the rear chassis tube *B* is a swinging arm *J* carrying at its outer end a stub axle *K* for the rear road wheel. Road shocks are absorbed by a spring or hydraulic shock absorber *L*. At the rear end of the chassis is a bearer plate *M* carrying an internal combustion engine *N* with its crankshaft transverse of the chassis, that is to say, parallel with the axis of rotation of the road wheels. In line with the crankshaft of the engine is a gearbox and fluid flywheel or other torque converter unit *O*, a freewheel device *P*, a pair of universal joints *R* and *S*, and sliding member *T*, through which the drive is taken to the offside road wheel *U*. A fuel tank *V* is conveniently mounted above the engine and to rear of the seat. The chassis and body may be made of material other than steel—for example, a synthetic plastic having the necessary strength. Both rear wheels may be driven from the engine in a manner illustrated in the specification.—*April* 4, 1956.

TOOLS AND WORKSHOP APPLIANCES

747,508. September 22, 1953.—PLIERS AND LIKE HAND TOOLS, H. Brindley, Ltd., 47–48, Vincent Parade, Birmingham, 12. (*Inventor: Raymond Dennis Icke.*)

The invention has for its object to provide a tool having jaws moving with a parallel or substantially parallel action. As shown in the drawing, the handles *A* of the tool are of channel section for the main part and at their upper parts form two extended plates *B*, which are interengaged by a common pivot *C*. Attached at *D* to the upper extremity of the extensions *B* are the jaws *E*. Each jaw comprises an elongated block of metal pivoted at *D* to the upper extremities of the extensions of the handles. The lower parts *F* of the jaws are continued into the hollow handle *A*, where they are each provided with a closed ended slot *G* of suitable shape, and this slot co-operates with a pin *H* fixed in the handle. As the handles are opened and closed the pins *H* co-operate



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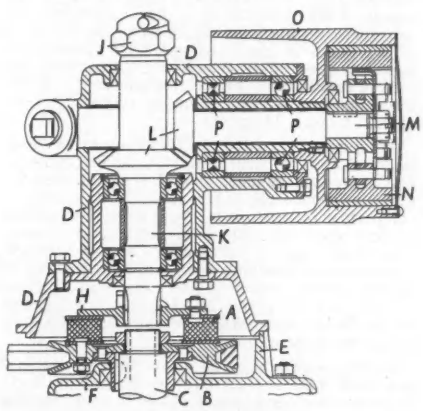
with the slots *G* ensuring the parallel actuation of the jaws. The usual compression spring may be interposed between the halves of the handle and the jaws *E*. The parallel opening and closing movement provides for an axial alignment of any protruding perforating and registrable parts carried by the jaws.—*April* 4, 1956.

AGRICULTURAL ENGINEERING

747,353. September 30, 1953.—POWER TAKE-OFF FOR AN I.C. ENGINE, David Brown Tractors (Engineering), Ltd., Meltham Mills, Meltham, Huddersfield. (*Inventors: Charles Hartley Hull qnd Harry Horsfall.*)

The invention relates to power take-off devices for I.C.-engined vehicles, such as agricultural tractors, and has for its object to provide an improved power take-off which will have the advantage of being independent of the normal transmission clutch. Referring to the drawing, a power take-off is con-



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nected by means of a suitable flexible coupling *A* to the usual fan belt pulley *B* mounted on the end of the engine crankshaft *C*. A casing *D* for the unit bolts on to a suitable part-cylindrical flange *E* on the engine casing *F* and encircling the fan belt pulley on all sides except that on which the belt leaves and returns to the pulley. Instead of the clutch starting dog nut being mounted on the end of the crankshaft *C*, it is made integral, as indicated, with a disc *H* forming part of the flexible coupling *A*, a starting nut *J* being provided on an extension of the input shaft *K* of the unit. A right-angled bevel gear drive *L* is preferably incorporated as shown in the unit, and the driven shaft *M* of the unit has fast upon it the spider or equivalent member of a centrifugal clutch *N*, the outwardly movable parts of which are adapted to engage with a belt pulley *O*. An extension of the pulley hub is mounted in suitable bearings *P* journalled in the casing *D* of the unit. The shaft *M* is carried in plain bearings in an axial bore of the extension. The clutch *N* is adapted to come into action at a convenient engine speed, for instance, by opposing the action of centrifugal force on the outwardly-movable parts of the clutch, up to a given point, by a predetermined spring force. Thus no separate controls are required, it being simply necessary to insert the splined end of the shaft *K* into the opening in the disc *H* forming part of the coupling *A* fast with the shaft *C*; secure the casing *D* to the engine casing; and start the engine of the vehicle, throttling up or down to engage or disengage the pulley *O* as desired.—*April* 4, 1956.

Launches and Trial Trips

HOROMYA, oil tanker ; built by Hawthorn Leslie (Shipbuilders), Ltd., for Shell Tankers, Ltd.; length overall 557ft, breadth moulded 69ft 3in, depth moulded 39ft, deadweight 18,000 tons ; thirty-three cargo oil compartments, one main cargo pump room, four vertical centrifugal turbine-driven cargo oil pumps, two 550kW geared turbo-alternators, one 200kW diesel-driven alternator ; one set of double reduction geared turbines, maximum power 8250 s.h.p., take steam at 500 lb per square inch and 800 deg. Fah. from two Foster-Wheeler " D " pattern boilers. Launch, February 24th.

VOLVULA, oil tanker ; built by Swan, Hunter and Wigham Richardson, Ltd., for Shell Tankers, Ltd.; length between perpendiculars 635ft, breadth moulded 84ft 3in, depth moulded 46ft 3in, load draught 34ft 6in, deadweight 31,000 tons, service speed 16¼ knots ; thirty cargo oil compartments, one cargo oil pump room, four 1160 tons per hour turbine-driven cargo pumps, three stripping pumps, steam deck machinery, two 550kW turbine-driven alternators, one 150kW diesel-driven alternator; one set double reduction geared turbines built by the Wallsend Slipway and Engineering Co., Ltd., maximum power 14,500 s.h.p. at 109 propeller r.p.m., steam supplied at 600 lb per square inch and 850 deg. Fah. by two Babcock and Wilcox integral furnace boilers. Launch, February 27th.

VIVIEN LOUISE, oil tanker ; built by the Furness Shipbuilding Company, Ltd., for the British Oil Shipping Company, Ltd.; length between perpendiculars 560ft, breadth moulded 80ft, depth moulded 42ft 3in, deadweight 24,800 tons on 32ft 4in summer draught ; twenty-seven cargo oil tanks, one main cargo pump room, three 1000 tons per hour turbine-driven centrifugal cargo pumps, three 150 tons per hour vertical duplex stripping pumps ; two 350kW turbo-generators, one 75kW diesel-driven generator ; one set of Metropolitan-Vickers double reduction geared turbines, 7300 s.h.p. at 100 propeller r.p.m. normal power, 8200 s.h.p. at 104 propeller r.p.m. maximum power, two Foster-Wheeler " D " boilers supply steam at 450 lb per square inch and 750 deg. Fah. Launch, February 28th.

GRANTON FALCON, trawler ; built by John Lewis and Sons, Ltd., for Messrs. Carnie and Gibb ; length overall 130ft, breadth 25ft, depth moulded 12ft, fish room 6400 cubic feet, electric trawl winch, 1000 fathoms of 2¾in warp, one 20kW diesel-driven generator, one 10kW diesel-driven generator, also 121kW diesel-driven trawl winch generator ; British Polar Mark M.44 M diesel engine, 640 b.h.p. at 250 r.p.m.—Launch, March 1st.

VOLA, oil tanker ; built by Hawthorn Leslie (Shipbuilders), Ltd., for Shell Tankers, Ltd.; length overall 660ft, breadth moulded 84ft 3in, depth moulded 46ft 3in, deadweight 31,000 tons ; thirty cargo oil compartments, one main cargo pump room, four vertical centrifugal turbine-driven oil cargo pumps ; two 550kW geared turbo-alternators, one 150kW diesel-driven alternator ; one set of double reduction geared turbines, maximum power 14,500 s.h.p., steam at 600 lb per square inch and 850 deg. Fah. supplied by two Babcock and Wilcox integral furnace boilers. Trial, March 1st and 2nd.

SOUTHERN PRINCE, cargo liner ; built by Harland and Wolff, Ltd., at Govan, for the Prince Line, Ltd.; length between perpendiculars 435ft, breadth moulded 61ft, depth moulded to shelter deck 38ft 6in, gross tonnage 7917 tons ; two continuous decks, eight watertight compartments, five holds, one 50-ton, four 10-ton and twelve 5-ton derricks, sixteen steam winches, three 50kW steam-driven generators ; Harland and Wolff opposed-piston, single-acting, two-cycle oil engine, five cylinders, 750mm diameter by 2000mm combined stroke. Trial, March 8th.

ESSO PRESTON, bitumen tanker ; built by Hall Russell and Co., Ltd., for the Esso Petroleum Company, Ltd.; length between perpendiculars 280ft, breadth moulded 42ft, depth moulded 20ft 9in, deadweight 2300 tons ; bitumen or other petroleum products of flash point less than 150 deg. Fah. carried in five centre cargo tanks, wing tanks carry water ballast, one cargo pump room, two 125 tons per hour rotary displacement cargo pumps ; steam deck machinery, two 130kW turbine-driven alternators, one 30kW diesel-driven alternator ; one triple-expansion steam reciprocating engine, 1300 i.h.p., two single-ended, oil-fired Scotch boilers supply steam at 225 lb per square inch and 500 deg. Fah. Trial, March 12th.

NORTHUMBRIAN PRINCE, cargo liner ; built by the Burntisland Shipbuilding Company, Ltd., for the Prince Line, Ltd.; length between perpendiculars 313ft, breadth moulded 46ft 3in, depth moulded to shelter deck 27ft 9in, draught 19ft 4in, deadweight 3450 tons; twelve passengers; three holds, one 25-ton and six 5-ton derricks, steam deck machinery ; Ailsa-Doxford opposed-piston oil engine, three cylinders, 560mm diameter by 2160mm combined stroke, 2300 b.h.p. at 120 r.p.m. Launch, March 14th.

Catalogues and Brochures

BRITISH ROPES, Ltd., Carr Hill, Doncaster.—Publication No' 25, describing the manufacture of wire ropes and their uses.

BUCK AND HICKMAN, Ltd., Whitechapel Road, London, E.1.—Folder dealing with hexagon socket head stripper bolts, cap screws, set screws, and wrenches, giving dimensions and price.

ELECTRO-HYDRAULICS, Ltd., Liverpool Road, Warrington, Lancs.—Leaflet illustrating a range of swivel couplings and typical swivel connections.

EXPANDITE, Ltd., Chase Road, London, N.W.10.—Leaflet dealing with " Plastijoint " bituminous putty used as a lasting weatherproof protective seal.

SOUTH BEND LATHE WORKS, South Bend 22, Indiana, U.S.A.—" 50th Anniversary Catalogue, 1906–1956," illustrating a range of lathes manufactured by this firm.

GEORGE TAYLOR AND SON (ENGINEERS), Ltd., Swan Lane, Coventry.—Leaflet describing " Taylor " vertical milling machine used for toolroom and production.

LANCASHIRE DYNAMO SWITCHGEAR, Ltd., Hurst Green, Oxted, Surrey.—Folder dealing with a range of heavy industrial switchgear, giving specifications and price list.

NETTLE ACCESSORIES, Ltd., Harper Road, Wythenshawe, Manchester, 22.—Catalogue illustrating items in the range of electrical accessories with price list attached.

METALECTRIC FURNACES, Ltd., Smethwick, Birmingham.—Illustrated catalogue dealing with direct-arc melting furnaces used in modern steel works and foundry plants.

THE GENERAL ELECTRIC COMPANY, Ltd., OF ENGLAND, Fraser and Chalmers Engineering Works, Erith, Kent.—Illustrated catalogue dealing with " Sherwen " electromagnetic vibrating equipments designed to withstand the force applied to them without exceeding the fatigue or elastic limit.

WAILES DOVE BITUMASTIC, Ltd., Hebburn, Co. Durham.—Booklet illustrating some of the industrial applications of " Bitumastic " coatings for the prevention of corrosion. A detailed specification is given for each type of " Bitumastic " with photographs showing some typical works where this material is used.

BALDWIN INSTRUMENT COMPANY, Ltd., Brooklands Works, Dartford, Kent.—Leaflet illustrating the uses of the " Atomat " nucleonic thickness gauge. The applications described include the papermaking industry, board making, metal rolling, plastics and rubber. Inquiries regarding special gauging problems are invited.

GRESHAM AND CRAVEN, Ltd., Ordsall Lane, Salford, Manchester, 5.—Illustrated booklet entitled " Automatic Vacuum Brake Equipment for Railway Vehicles." Brief details of the history of the firm are given in the preface. The following chapters include both general and detailed descriptions of the vacuum automatic brake, together with notes on maintenance and testing. Six large-scale diagrams are included as separate plates.

DUNLOP RUBBER COMPANY, Ltd., General Rubber Goods Division, Cambridge Street, Manchester, 1.—Illustrated brochure entitled " A Pattern to Make it Possible," reviewing silicone rubber, its special properties, achievements to date, and possibilities for the future. Statistical tables indicate its oil and fuel resistance, hardness value in relation to ageing, and reaction to high temperature. A series of photographs demonstrates that after two years' exposure in an industrial atmosphere its physical deterioration is negligible. Other photographs illustrate the uses of silicone in scientific research and in industry generally.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, May 4th.—LIVERPOOL BRANCH : Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, 2, " Underfloor Duct System," W. J. Mann, 7.30 p.m.
Mon., May 7th.—LEEDS BRANCH : Great Northern Hotel, Leeds, " Ultra-Violet and Infra-Red Lamps," H. Laycock, 7.30 p.m. ——N.E. LONDON BRANCH : Angel Hotel, Ilford, " Heavy Power Units in Dock Installations," F. W. Sheppard, 8 p.m.
Tues., May 8th.—LUTON BRANCH : Midland Hotel, Williamson Street, Luton, Lecturette by C. C. Morgan, 8 p.m.
Wed., May 9th.—BIRMINGHAM BRANCH : Room 3, Chamber of Commerce, New Street, Birmingham, Film Show, 7.15 p.m. ——HALIFAX BRANCH : Crown Hotel, Horton Street, Halifax, " Modern Fire Alarm Equipment," Mr. Cobham, 7.30 p.m.
Fri., May 11th.—BRISTOL AND WEST OF ENGLAND BRANCH : Grand Hotel, Bristol, Lecture by G. L. Leighton, 7.30 p.m.

CHADWICK PUBLIC LECTURE

Mon., May 14th.—Barnes Hall, Royal Society of Medicine, 1, Wimpole Street, London, W.1, " The Influence of Chadwick on American Public Health," Huntington Williams, 5 p.m.

INCORPORATED PLANT ENGINEERS

Tues., May 8th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, " Mechanical Handling," Film, 7.15 p.m.
Thurs., May 10th.—GLASGOW BRANCH : Scottish Building Centre, 425–427, Sauchiehall Street, Glasgow, " Paints in Relation to Maintenance," T. H. Bullions, 7 p.m.—N.E. BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, " Incentive Bonus for Maintenance Work," A. J. Speakman, 7 p.m.
Wed., May 16th.—KENT BRANCH : Bull Hotel, Rochester, " Air Conditioning in Engineering," K. W. Dale, 7 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., May 14th.—LEICESTER CENTRE : E. Midlands Electricity Board, Charles Street, Leicester, Annual General Meeting, 6 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., May 14th.—STUDENT LECTURE : 85, Minories, London, E.C.3, " The Shipping Industry," A. Watson, 6.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., May 15th.—COVENTRY SECTION : Room A5, Technical College, Coventry, " Investment Casting for Aircraft Engines," D. F. B. Tedds, 7.30 p.m.

INSTITUTE OF NAVIGATION

Wed., May 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, The James Cook Exhibition at Greenwich, G. P. B. Naish, "Ballooning," C. H. Gibbs-Smith, D. N. Harrison, and C. S. Durst, followed by a Discussion, 5 p.m.

INSTITUTE OF PHYSICS

To-day, May 4th.—NON-DESTRUCTIVE TESTING GROUP : 47, Belgrave Square, London, S.W.1, a Symposium on " Principles of Penetrant Methods," H. L. Carson, W. G. Cook and R. Schnurmann, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Fri., May 11th.—S. WALES GROUP : S. Wales Institute of Engineers, Park Place, Cardiff, " The Commer ' T.S3 ' Two-Stroke Diesel Engine," E. W. Coy, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., May 8th.—PUBLIC HEALTH MEETING : Great George Street, Westminster, London, S.W.1, " The Construction of Middleton Connecting Sewer in North Manchester," E. H. Collier, 5.30 p.m.——NORTHERN COUNTIES' ASSOCIATION : Neville Hall, Newcastle upon Tyne, 1, Students' Annual General Meeting, followed by Films, 6.15 p.m.
Thurs., May 10th.—MIDLANDS ASSOCIATION : James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting, 6 p.m.——S.W. ASSOCIATION : Small Lecture Theatre, New Engineering School, University Walk, Bristol, 8, Annual General Meeting, " Archæological Finds in Chew Valley Lake," P. A. Rantz, 6 p.m.——STRUCTURAL AND BUILDING MEETING : Great George Street, Westminster, London, S.W.1, " The Allowable Settlements of Buildings," A. W. Skempton and D. H. Macdonald, 5.30 p.m.
Tues., May 15th.—ORDINARY MEETING : JAMES FORREST LECTURE: Great George Street, Westminster, London, S.W.1, " Marine Physics," G. E. R. Deacon, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., May 7th.—S. MIDLAND CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, " Problems of Hydro-Electric Design in Mixed Thermal Hydro-Electric Systems," T. G. N. Haldane and P. L. Backstone, 6 p.m.
Tues., May 8th.—MEASUREMENT AND CONTROL SECTION : Savoy Place, London, W.C.2, " Ship Stabilisation : Automatic Controls, Computed and in Practice," J. Bell, 5.30 p.m.
Wed., May 9th.—RADIO AND TELECOMMUNICATIONS SECTION : Savoy Place, London, W.C.2, " Time Sharing as a Basis for Electronic Telephone Switching : A Switched Highways System," L. R. F. Harris, 5.30 p.m.
Fri. to Sun., May 11th to 13th.—UTILISATION SECTION : Summer Visit to Harrogate.
Mon., May 14th.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, S.W.1, Discussion on " An Elementary Presentation of the Principles of Magnetism and Electromagnetic Induction with Demonstrations," opened by K. A. Hayes, 6 p.m.——LONDON GRADUATES' AND STUDENTS' SECTION : Savoy Place, London, W.C.2, Annual General Meeting, followed by a Film Show, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, May 4th.—GENERAL MEETING IN CONJUNCTION WITH THE HYDRAULICS GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, " Three-Dimensional Motion in Axial-Flow Impellers," S. P. Hutton, " Performance of an Axial-Flow Pump," E. A. Spencer, 5.30 p.m.
Wed., May 9th.—LUBRICATION GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Discussion, " What is Lubrication," 6.45 p.m.
Fri., May 11th.—GENERAL MEETING IN CONJUNCTION WITH THE INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP : 1 Birdcage Walk, Westminster, London, S.W.1, " The Influence of the Gas Turbine Axial-Flow Aero-Engine on Blade Manufacturing Methods," R. R. Whyte, 5.30 p.m.
Wed., May 16th.—LONDON GRADUATES' SECTION : 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting and paper, 6.30 p.m.——N.W. GRADUATES' SECTION : All-day visit to Austin Motor Works, Longbridge, Birmingham.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Mon., May 7th.—ORDINARY MEETING : Institution of Electrical Engineers, Savoy Place, London, W.C.2, " An Introduction to Microwaves and Wave-Guide Transmission," C. F. Floyd, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Tues., May 8th.—BIRMINGHAM GRADUATE SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, Film Evening, 7 p.m.
Wed., May 16th.—WOLVERHAMPTON GRADUATE SECTION : Technical College, Wulfruna Street, Wolverhampton, " The Use of Air-Operated Fixtures in Mass Production," J. F. Smith, 7.30 p.m.

NEWCOMEN SOCIETY

Wed., May 9th.—DICKINSON BIENNIAL MEMORIAL LECTURE : Lecture Theatre, Science Museum, South Kensington, London, S.W.7, " Iron and Steel Production in Ancient and Mediæval China," Joseph Needham, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Wed., May 9th.—ALL-DAY SECTION LECTURE ON SUPERSONIC FLIGHT : Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, " Propulsion," A. V. Cleaver ; " Aerodynamics," P. J. Duncton ; " Structures," D. J. Farrar ; " Cabin Conditions, Controls, &c.," H. H. Gardner, 10 a.m.
Tues., May 15th.—SECTION LECTURE : 4, Hamilton Place, London, W.1, " Medical Aspects of Flight Comfort and Efficiency," A. Buchanan Barbour, 7 p.m.
Thurs., May 17th.—Royal Institution, Albemarle Street, London, W.1. Wilbur Wright Lecture, " The Aerodynamic Art," Sir William S. Farren, 6 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., May 7th.—ORDINARY GENERAL MEETING : 12, Great George Street, Westminster, London, S.W.1, " The Price of Freedom," Right Honourable Lord Justice Denning, 5.30 p.m.

ROYAL SOCIETY OF ARTS

Wed., May 9th.—John Adam Street, Adelphi, London, W.C.2, " Automation," Right Hon. the Earl of Halsbury, 2.30 p.m.

SCIENTIFIC FILM ASSOCIATION

Wed. to Fri., May 16th to 18th.—Ashorne Hill, Near Leamington Spa, Conference on Film as an Aid to Management.

SOCIETY OF ENGINEERS

Mon., May 7th.—Geological Society, Burlington House, Piccadilly, London, W.1, " Oil-Fired Packaged Portable Boilers," D. F. Brice, 5 p.m.

UNIVERSITY OF LONDON

Mon. to Fri., May 7th to 11th.—King's College, Strand, London, W.C.2, a Course of Four Lectures on Civil Engineering, Hjalmar Granholm, 5.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Mon., May 14th.—LONDON BRANCH : 45, Great Peter Street, Westminster, London, S.W.1, " Mining Machinery," 7 p.m.